INTER AVIA

Review of World Aviation

In this Issue:

Airline to the Frozen North

Charles H. de Levis-Mirepoix : Balance Sheet of French Commercial Aviation

Convair XC-99 — Efficacity of Aeroplane Armament — Anti-Icing — Northrop YB-49

S/Ldr. Robert Kronfeld : From Tailless Glider to Jet Aeroplane

W. Just/K. Sahliger : Approaching Sonic Speed

Economic Aspects of Aviation

VOLUME III No 1 JANUARY, 1948

GENÈVE-*Cointrin*

The inter-continental airport of Geneva-Cointrin,
with Lake Geneva and the Mont Blanc range in the background

ONLY RUNWAY IN SWITZERLAND SUITABLE FOR INTER-CONTINENTAL TRAFFIC

RUNWAY LENGTH, 6500 ft.

ORDER FORM

INTER AVIA

Review of World Aviation

Please write in block letters

English edition · French edition
Spanish edition · German edition

(Cross out where necessary)

..... *Yearly subscription beginning* ..... *19*.....

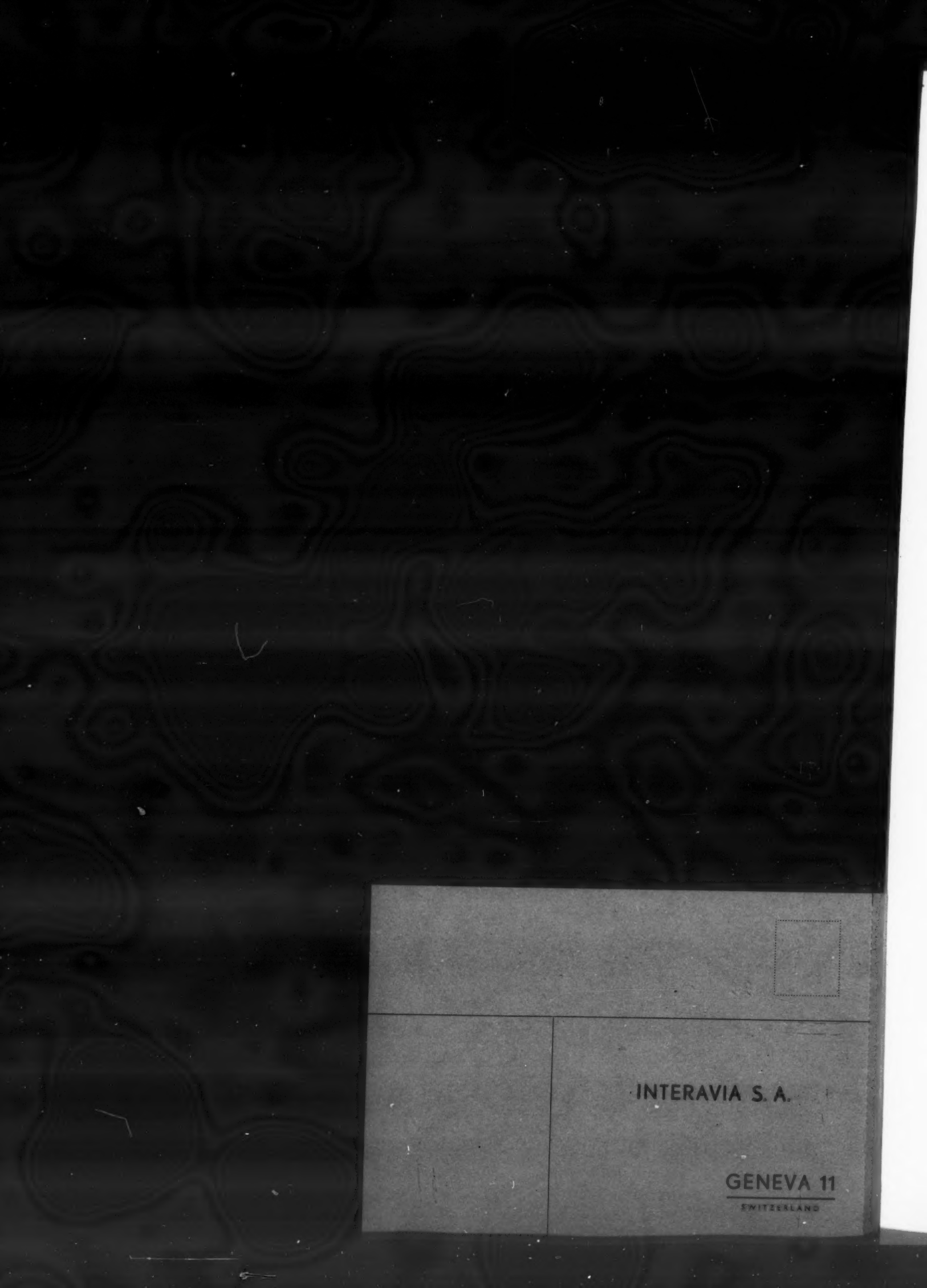
Name : ..... Executive Position : .....

Address : .....

Town : ..... Country : .....

Manner of payment : .....

Yearly subscription rates : Switzerland : Sw. Frs. 20.—; U. S. A. : $ 3.00; Great Britain : £ 2. 0. 0.; France : Fr. Frs. 1000.—; Belgium : B. Frs. 350.—; Other countries : Sw. Frs. 30.—.


INTERAVIA S. A.
GENEVA 11
SWITZERLAND

INTERAVIA

Review of World Aviation

OFFICIAL ORGAN OF THE FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE (F. A. I.)

Volume III | January, 1948 | No. 1

Board of Directors: Marcel Devaud, Edgar Primault, E. E. Heiman, H. O. C. Messner, E. V. D. Wight, Jr.

Editors: E. E. Heiman. H. T. Biland, E. de Tavel, E. Herzfeld.

Assistant Editors: Patrick A. Sauter, E. Cherbuliez, J. Jenny, A. de Rham, A. Arbex, E. Baur, K. Müller.

Art Editor: H. W. Mahrer.

Advertising: Percy A. Blackburn.

Publishers and Distributors: Interavia S. A. **Proprietors:** Volamecum S. A.

Contents

Marginal Notes		**11**
Balance Sheet of French Commercial Aviation	CHARLES HENRI DE LEVIS-MIREPOIX	**12**
Convair XC-99		**20**
Aeroplane Drag When Approaching Sonic Speed	W. JUST, D. Sc., AND K. SAHLIGER, B. Sc.	**27**
Anti-Icing on Boeing's Heavy Aeroplanes		**34**
Errors Evidenced by Direction-Finders	ERKKI HEINO	**36**
Assessing the Efficacity of Aeroplane Armament	O. P. FUCHS AND H. KOTTAS	**38**
Airline to the Frozen North	HERMANN SCHOENEN	**43**
Northrop YB-49		**47**
From Tailless Glider to Jet Aeroplane	S/LDR. ROBERT KRONFELD	**48**
Economic Aspects of the U.S. Aviation Industry	JEREMY C. JENKS	**51**
Mañana por la mañana		**53**
There's No Place Like Home!	YVES GROSRICHARD	**55**
Book Reviews		**56**
Month in Review		**57**

Cover page:

First take-off of the Convair XC-99

Appears Monthly in Four Editions: English, French, Spanish and German.

Publishing and Editorial Offices, Subscription Department: Interavia S. A., 20, Cité, Geneva.

Advertising Department: 13, Corraterie, Geneva. Telephones: 5.42.32, 5.42.33 and 5.42.34. Cables and Telegrams: Interavia-Geneva.

Prices: Switzerland: annual subscription, Sw. frs. 20.00; single copy, Sw. frs. 2.00. Annual subscriptions in other countries: U. S. A., $ 8.00; Great Britain, £ 2 0s 0d; France, Fr. frs. 1,000.00; Belgium, Belg. frs. 350.00; Denmark, Kr. 40; Argentina, $ m/n 35.00; all other countries, Sw. frs. 30.00.

Agents and Distributing Offices:

INTERAVIA BELGIUM:	11 Rue de Crayer, Brussels, or Office de Publicité, 36 Rue Neuve, Brussels.
INTERAVIA DENMARK:	Daemningen 21, Copenhagen/Valby. Dansk Centralagentur, Stormgade 20, Copenhagen.
INTERAVIA FRANCE:	6 Place de la Madeleine, Paris 2e.
INTERAVIA GREAT BRITAIN:	Eagle House, 109 Jermyn Street, London S. W. 1.
INTERAVIA HOLLAND:	Diepenheim (O) Warmelo S. 13. M. van Gelderen & Zn., Postbox 826, Amsterdam-C.
INTERAVIA HUNGARY:	Ibusz, V. Vigador-tér 2, Budapest.
INTERAVIA IRELAND:	33 Kildare Street, Dublin.
INTERAVIA ITALY:	39 Viale di Villa Massimo, Rome.
INTERAVIA SPAIN:	Velásquez 87 or Lista 60, Madrid.
INTERAVIA SWEDEN:	Postbox 29, Linköping.
INTERAVIA U. S. A.:	292 Madison Avenue, Room 902, New York, N. Y. Subscriptions also from the American News Co., 131 Varick Street, New York, N. Y.
INTERAVIA ARGENTINA:	Charcas 2745, Buenos Aires.
INTERAVIA BRAZIL:	38 Rua Teofilo Otoni, Rio de Janeiro.
INTERAVIA EGYPT:	B. P. 134, Cairo.
INTERAVIA SOUTH AFRICA:	P. O. Box 6073, Johannesburg.

Copyright 1947 by Interavia S. A., Geneva, Switzerland

Printed in Switzerland

Imprimeries Populaires, Geneva — Héliographia S. A., Lausanne
Imprimerie "Tribune de Genève", Geneva

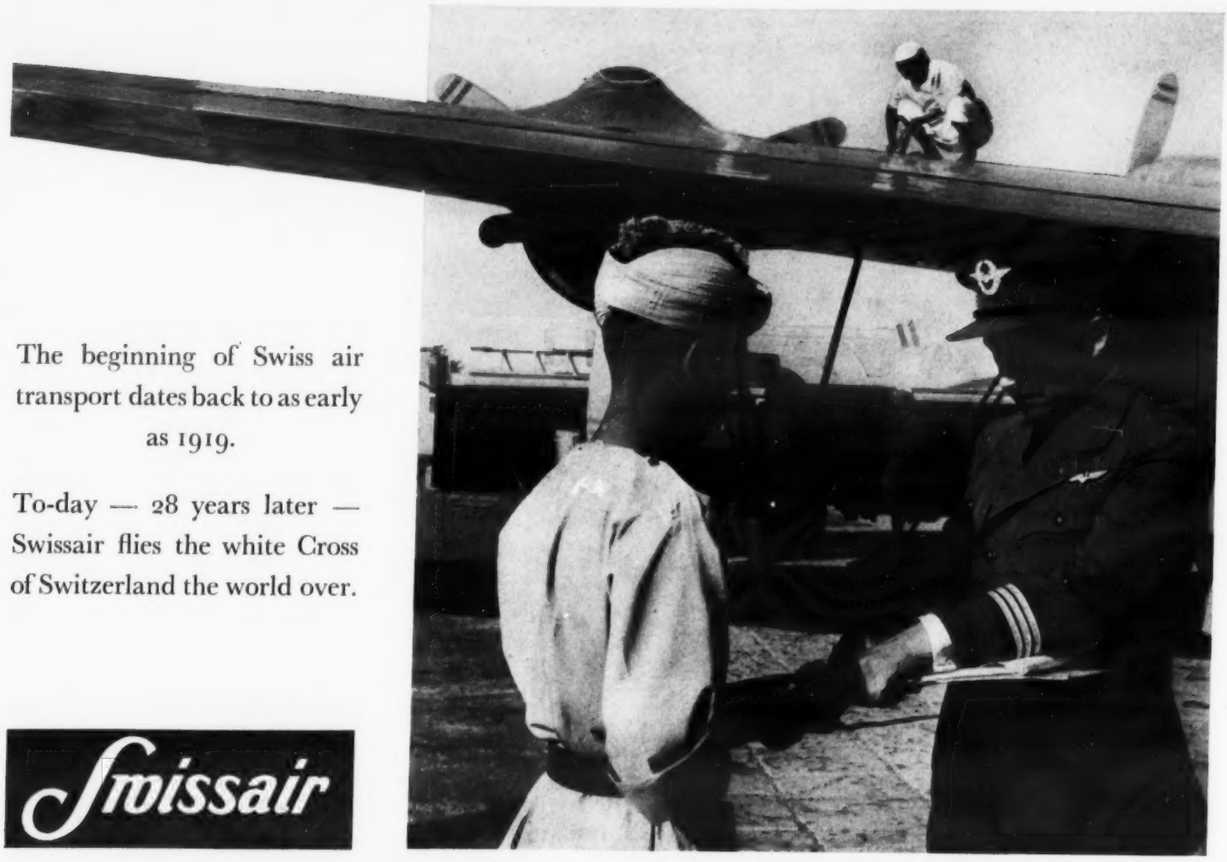
Fly and Ship your goods by K·L·M

There they go!

Day and night the proud planes of K. L. M., elegant ambassadors of commerce, are flying to all points of the compass, affording speedy, comfortable transport to keep you in touch with your business associates overseas. Manned by crews whose flying experience covers millions of air-miles, the modern aircraft of K.L.M. provide top-flight comfort and efficiency. Fly your freight by K. L. M. too; for samples, packages, etc., it is a safe and speedy form of transport, which will be appreciated by each and everyone of your clients.

K·L·M

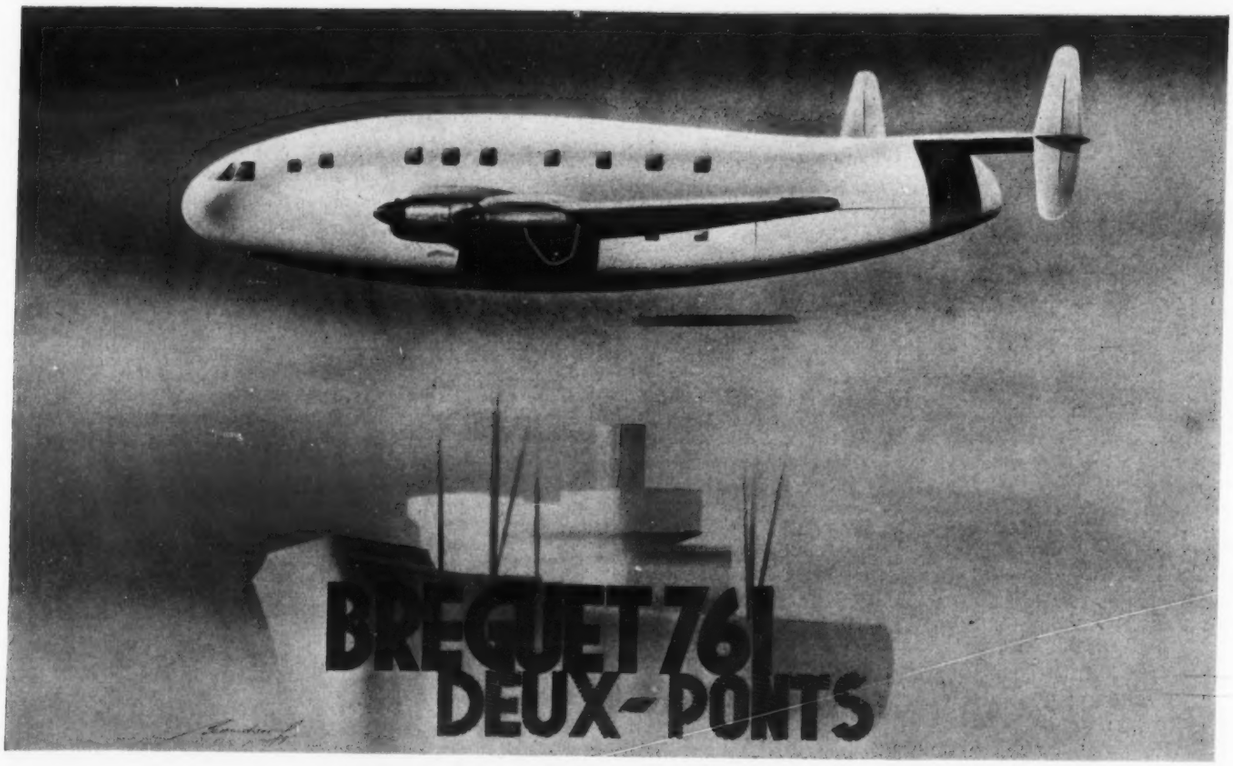
ROYAL DUTCH AIRLINES



The beginning of Swiss air transport dates back to as early as 1919.

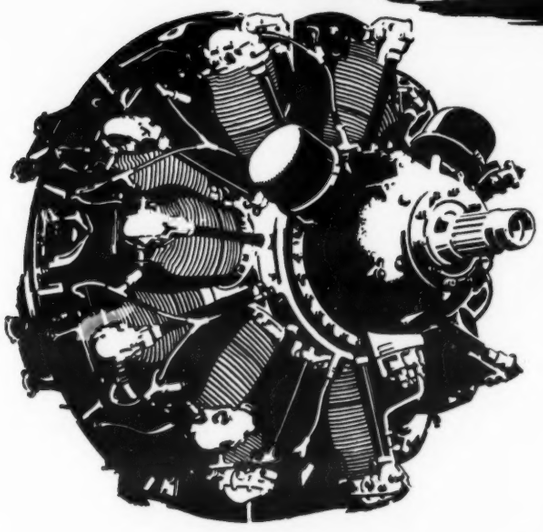
To-day — 28 years later — Swissair flies the white Cross of Switzerland the world over.

Swissair



ECONOMICAL AIR TRANSPORTATION

High performance four-engined transport aircraft for passengers and freight. Distances up to 2500 miles. Gross weight, 87000 lbs. - Payload over 620 miles, 31000 lbs. - Loading volume 5850 cu.ft. - Cruising speed, 220 m. p. h.



A NEW ENGINE

Designed to fill a need...

The new Pratt & Whitney R-2180 Twin Wasp engine was designed especially to fill the need for an engine in the 1650-horsepower class to power new transport aircraft. Already it has been selected for the SAAB-90 Scandia, a new 32-passenger twin-engined Swedish airliner.

In addition, this rugged, economical engine offers interesting possibilities for improving the performance of many existing twin-engined and four-engined aircraft.

UNITED AIRCRAFT
Export Corporation
EAST HARTFORD, CONNECTICUT, U. S. A.

European Office :
4, rue Montagne-du-Parc
Brussels, Belgium

Sales Representative for Australia : BROWN & BUREAU LIMITED · 422 Collins Street · Melbourne C. 1

PRATT & WHITNEY	HAMILTON STANDARD	CHANCE VOUGHT	SIKORSKY
ENGINES	PROPELLERS	AIRPLANES	HELICOPTERS

GENEVA

INTERNATIONAL FREE PORT

close to the airport

for all goods, valuables and securities

in transit

All information from : **SOCIÉTÉ D'EXPLOITATION DES PORTS-FRANCS et des ENTREPOTS de l'ÉTAT de GENÈVE**

Telegrams "Portfranc Geneva"

— COUPLOFLEX : Control of camber changing and split-type landing flaps.
— DYNAFLEX : Elastic power plant mountings.
— COUPLINGS.
— FLEXIBLE EXTENSION SHAFTS : Airscrew drive and accessory relays — airscrew hubs — elastic antenna mountings — undercarriages.
— SHOCK ABSORBERS : Undercarriage retraction — cannon recoil brakes.
— ISOFLEX and ISODYNES : Shock-absorbing suspension of instrument panels, compasses, radio, etc...
— PERIFLEX : Flexible drives for blowers, auxiliary equipment, etc...
— RADIAFLEX : Elastic couplings for test benches, wind tunnels, etc...
— MISCELLANEOUS : Airscrew spinners — radiators and tanks — passenger seats.

PAULSTRA

COGÉVÉ

9 RUE HAMELIN · PARIS · 16e

PASSY 21-74 . 21-75

PAULSTRA

We are
specialists in

Hangar construction

FROMSON Construction Co. of Canada

Engineers and Contractors

20, St Ann's Sq. **Manchester**

20, av. Palmerston **Brussels**

First issue
January 1948

INTERAVIA S. A., GENEVA II

Vice-President in Charge of a Safe Smooth Flight

Besides the pilot and copilot, there's a third man in the *Constellation* cockpit. He is the flight engineer—a man who might also be known as the Vice-President in Charge of a Safe, Smooth Flight.

His contributions to the passengers' comfort and security are both direct and indirect.

He superintends the smooth operation of the plane's four mighty engines. And, while the plane flies high over the weather at 20,000 feet the flight engineer keeps the cabin altitude at a comfortable 8,000 feet by his operation of the *Constellation's* pressurizing system. He also oversees the cabin heating and ventilating devices.

And indirectly, he improves the flight by handling 60% of the *Constellation's* controls and indicators. This leaves the pilot and copilot free to concentrate on flying the plane smoothly and surely.

The flight engineer is just one of the many extras which results in the Lockheed *Constellation's* making twice as many transatlantic flights as all other air transports combined.

Lockheed Aircraft Corporation

Burbank, California

LOOK TO LOCKHEED FOR LEADERSHIP

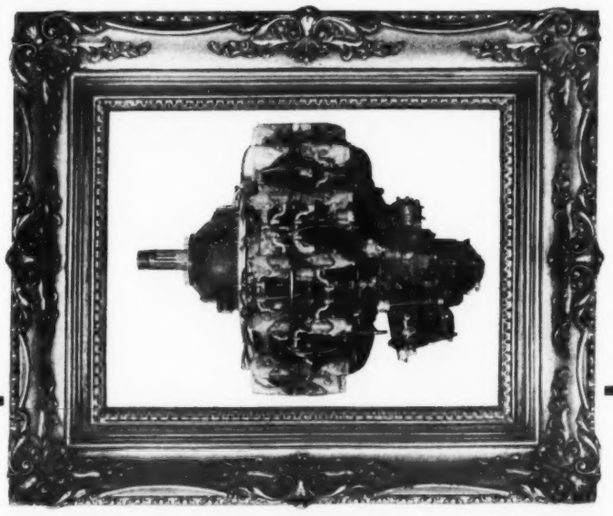
Airlines operating — or soon to operate — *Constellations* are :
Aer Lingus and Aerlinte Eireann (Irish Air Lines), Air France, AOA (American Overseas Airlines), Aerovias Guest S. A., British Overseas Airways Corporation, Eastern Air Lines, KLM Royal Dutch Airlines, LAV Linea Aeropostal Venezolana, Pan American World Airways, Panair do Brasil, Qantas Empire Airways, Ltd., Trans World Airline.

Aviation Advances with

"Nearly 20 years ago Dunlop Wheels and Tyres were fitted to the Westland Wessex. In those days the Armstrong Whitworth A. W. 52 would have appeared to be a futuristic dream. Yet even then Dunlop research was building for the future. Dunlop equipment for the A. W. 52, first British Twin Jet Propelled Flying Wing, includes Tyres, Wheels and Brakes, Brake Operating Equipment, Flexible Hose Assemblies, Pneumatic Jacks and Selectors for operation of the Hot Air Flaps. Just another proof of Dunlop Leadership."

DUNLOP

presenting the finest surplus engine in the world —



We have produced the Steward-Davis R-1830-92 conversion to meet all of the rigid specifications laid down by its original world-famous manufacturer, Pratt Whitney Aircraft. Conversion from engines of the R-1830-65 type according to factory recommendations makes this engine identical in every respect with the originally manu830factured R-1-92.

We have test-run, preserved for long-time storage, packaged for shipment, and warrantied this fine completely overhauled engine, and we have priced it at $1795 f.o.b. Los Angeles, to the aircraft operators of the world.*

We are prepated to stake our reputation on its performance.

FOR ADDITIONAL DETAILS: *Write or wire to Customer Service: Steward-Davis, 13501 S. Western, Gardena, California. Cable STEDAV.*
**Copy of Warranty upon request.*

Steward-Davis • 13501 SOUTH WESTERN · GARDENA, CALIFORNIA · U. S. A.

1916

PREMIER
TURBO-COMPRESSEUR
DE SURALIMENTATION

1946

PREMIER TURBO-RÉACTEUR
FRANÇAIS

SOCIÉTÉ RATEAU

LA COURNEUVE (Seine)

TURBINES A VAPEUR ET A GAZ
POUR TOUTES APPLICATIONS

SOUFFLERIES SUBSONIQUES
ET SUPERSONIQUES

STATIONS D'ESSAIS
DE MOTEURS ET RÉACTEURS
AUX CONDITIONS D'ALTITUDE

POMPES, SOUFFLANTES
VENTILATEURS
CENTRIFUGES ET AXIAUX

COMPRESSEURS A PISTONS

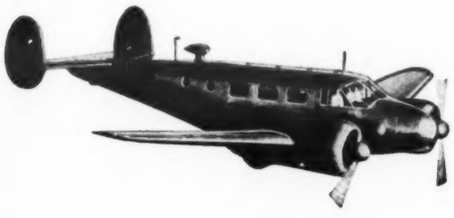
ROBINETTERIE
INDUSTRIELLE ET MARINE

The "Mounties" have an Air Arm, too!

The Royal Canadian Mounted Police Force, world standard for efficiency in civilian protection since 1873, uses nearly every form of transportation known... including the airplanes. Along with fine planes of Canadian manufacture, the "Mounties" are using Beechcraft twin-engine 18's because of their reliability speed and cruising range in all kinds of weather.

Business can well borrow a leaf from the Mounties' book of experience. The Beechcraft twin-engine Executive Transport—equipped with every navigating facility and comfortable in the extreme—is peial company transportation for both regular and emergency use. It accomodates up to nine people, operates with notable economy, and can land and take off from relatively small fields.

The hours—and fatigue—which the Beechcraft Executive Transport saves company officials and personnel make for an efficiency which is reckoned in dollars and cents by many of America's leading businesses. Your Beechcraft distributor is ready at any time to help you appraise your company's air transportation needs in the light of Beechcraft's wide experience in this field. Call on him.



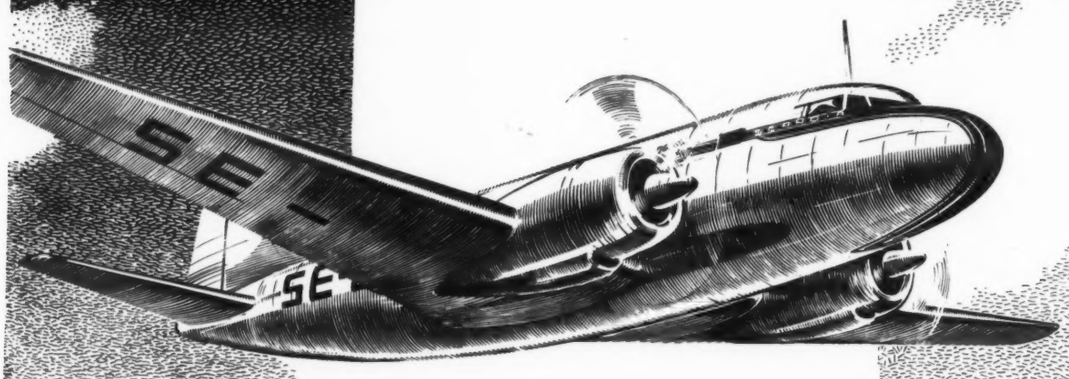
Beech Aircraft

CORPORATION WICHITA, KANSAS, U. S. A.

SWEDISH QUALITY

to the very tips of the wings

Sweden is famous for quality products — *Swedish quality* is a high mark for any product. Swedish designers and Swedish craftsmen have achieved a passenger plane of the highest international quality in the Saab Scandia — Swedish quality to the very tips of the wings!



Scandia

PERFORMANCE FIGURES

Passengers	32	★ Crew	2—5
Gross weight		32,380 lbs (14,700 kg)	
Cruising speed		250 MPH (405 km/h)	
Range at econ. cruis. speed		680 miles (1,100 km)	

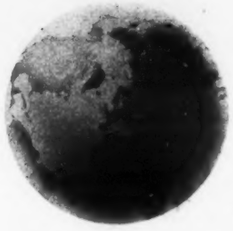
★

Front wheel Engines:

2 Pratt & Whitneys R-2180

SVENSKA AEROPLAN AKTIEBOLAGET • SAAB AIRCRAFT COMPANY • SWEDEN

Marginal Notes



A Tale for Children

It is traditional to begin the New Year with a tale of what has been and what lies ahead. We would like to leave aside this custom and, instead, start 1948 with a tale for children.

The Italian author, Curzio Malaparte, whose name has been internationally displayed on bookstalls during the past few years, wrote of his personal contacts with Italian Fascism, German Naziism and Russian Communism : Mussolini had developed quite a weakness for throwing him into prison every so often, Himmler's Gestapo merrily hunted him out of one country into another, and as a war correspondent he had his fill of the Russian front. His experiences are summarised in his book, "*Kaputt*," of which the English and French translations have enjoyed wide popularity.*

One chapter of this book contains a "*story about Neapolitan children and British aviators*" :

... "I was in Naples at the beginning of the war, when the first bombings began. I went to have supper one evening with a friend of mine who lives at the Vomero ... a high cliff that dominates the city ... It is an enchanting place and, up to a few years ago, it was a countryside with scattered little houses and villas lost among the greenery. Each house had its orchard, a few vines, a few olive trees and terraced embankments on which blossomed eggplants, tomatoes, cabbages, peas, scented basil, rose and rosemary ... Now the orchards have been turned into gardens ... Across the water, Capri stands out from the sea in a silvery mist ; on the right is Ischia with its high Epomaeo ; on the left the Sorrento shore can be seen in the transparent mirrors of the sea and sky, and still farther to the left is Vesuvius ... If one strolls through the lanes of the Vomero where it changes its name and is wedded to the Posillipo hills, between the trees and houses one can see the solemn and most ancient pine tree that shades Virgil's tomb. That is where my friend had his little rustic house and little orchard.

"While we waited for supper, we sat in the orchard under a vine arbor, smoking and talking quietly. When night began to rise from the sea ... my friend said, 'The night will be clear. They will certainly come. I must put the presents for the British flyers in the orchard.' I did not understand, and I was puzzled as I watched my friend enter the house and come out carrying a doll, a little wooden horse, a trumpet and two little bags of sweets which he, without saying a word and perhaps mischievously enjoying my bewilderment, went about carefully placing here and there among the rose bushes and lettuce clumps, on the pebbles of the narrow path and on the edge of a bowl in which a family of goldfish softly flashed.

"'What are you doing ?' I asked.

"He gazed at me with a serious expression and smiled. He told me that his two children, who were already in bed, had been overcome with a terrific fear during the first bombings, that the health of the youngest one had been seriously affected — and that he had evolved a means of changing the fearful bombings of Naples into an entertainment for his children. As soon as the alarm hooted through the night, my friend and his wife jumped out of bed and, gathering the two little ones in their arms, began shouting merrily : 'What fun ! What fun ! The British planes are coming to throw their presents to you !' They went down into their cellar that offered scant and ineffectual shelter and, huddling there, they passed the hours of terror and death laughing and shouting, 'What fun !' until the boys fell happily asleep dreaming about the presents from the British flyers. From time to time, as the crash of the bombs and the crumbling of buildings came nearer, the little ones awoke, and the father said : 'Now, now, they are throwing down your presents !' The two boys clapped their hands with joy, shouting : 'I want a doll ! I want a sword ! Daddy, do you think that the British will bring me a little boat ?' Toward dawn, when the hum of the motors moved off fading slowly into a sky that was already clear, the father and mother led the children by their hands into the garden, saying, 'Look for them, look ! They must have dropped them on the grass.' The two boys searched among the rose bushes, wet with dew, among the lettuce plants and the tomato stalks, and they found a doll here, a little wooden horse there and, farther off, a bag of candy. The two children were no longer afraid of bombings ; instead they waited anxiously for them and welcomed them joyfully. Some mornings, searching through the grass, they found little spring-propelled airplanes—undoubtedly poor British airplanes that those nasty Germans had brought down with their guns while they bombarded Naples to make Neapolitan children happy."

A tale for children : perhaps somewhat touching, and even reminiscent for some people—but still a tale for children, and symbolic of our era of insanity : horror cast in a poetic mould.

And now give me an idea for a New Year's tale to tell you whilst we are on the threshold of 1948. I would all too willingly leave this task to Their Excellencies, the Foreign Ministers, who at this very hour—in which I am racking my brains for something bright and cheerful to say on the prospects of the New Year—are meeting in London.

Of their discussions, I know no more than any other simple being who commits the error of briefly consulting the newspapers. Even reading them at length does not make me any wiser than Tom, Dick and Harry.

But I am neither blind nor deaf ; and I do not feel strong enough to be over-optimistic. I cannot help observing that the gap is widening between former Allies and the Western and Eastern conceptions of democracy. I frequently read the word "no" and fail to remember ever having read the word "yes." I discover that people are agitating and heading for trouble, declaring strikes, and are unable to buy toys for children ; indeed, they cannot even provide them with milk.

And, like many of my readers, I am also forced to ask myself whether 1948 will not bring about another such children's festival as Neopolitan parents gave, or had to give, for their kiddies.

There is no doubt that a next children's festival would be celebrated with unimaginable splendour. *EEH.*

* Published by : Casella, Naples, 1944. Denoel, Paris, 1947. E. P. Dutton & Co., Inc., New York, 1946.

Balance Sheet of French Commercial Aviation

BY CHARLES-HENRI LEVIS-MIREPOIX
Inspecteur Général de l'Aviation Civile et Commerciale.

The author was born in Paris on January 4th, 1912. He entered the Ecole Navale *at the very young age of seventeen, and specialised in aviation in 1934.*

Landplane and flying-boat pilot, M. de Levis-Mirepoix entered the Free French Forces in 1941, joined R. A. F. Transport Command, making numerous North and South Atlantic crossings in 1942 and 1943, and subsequently commanded a Coastal Command squadron until the time of the Allied landings in southern France.

Later called to the Cabinet of the President of the Provisional Government, he was charged by General de Gaulle to maintain the liaison with the Navy and Civil Aviation. When this department was handed over to the Ministry of Public Works and Transport, M. Jules Moch appointed him Inspector-General of Civil and Commercial Aviation.

Reconstruction.

Speed is not solely an attribute of flying. It leaves its imprint on all fields connected with aeronautics : research, production, transport organisation, legislation, etc. In view of this relentless evolution, where projects are obsolete before they are perfected, and constructions outclassed by better ideas before they can reach the practical stage, one must combine action with speed, if all is not to end up in smoke. Furthermore, every decision taken must be combined with factual knowledge gained through experience and clear imagination as to what the future holds in store. These are the psychological requisites of prolonged success in aviation ; though it is not always that their value is fully appreciated. And to them must be added other, equally indispensible qualities : energy, audacity, perseverance, etc. But as for these, however much we may respect the people endowed with them, we whall leave them out of our discussion. Have they not already inspired an over-abundance of printed matter ? And, besides, are they confined to aviation alone ?

Be that as it may, the weight of this intellectual and moral factor determines the aeronautical vitality of a State just as much as factors of geographical, economic, industrial, demographical or political nature do. For this reason it is fitting, while on the threshold of a study of French civil aviation with its inevitable dry statistics, to recall to mind the rôle played by *homo sapiens*. Moreover, it is without vain pride that we can assert that the efforts required in order to realise our ton-miles and passenger-miles were far greater than is evidenced by the relatively mute statistics.

As a matter of fact, the War dealt French civil aviation wounds which are manifested in two respects. Firstly, the asphyxiation of manufacturing and transportation industries, isolated from the Allied world for over four years : one only needs to make a comparison between 1939 and 1945, either from the standpoint of aeroplane performance, or of the density, length, rapidity and regularity of air transportation, to realise what havoc such a separation is capable of wreaking ; this alone could very well have proved mortal. But further consequences of the hostilities were the total destruction of all ground installations, disappearance of a very large number of qualified technicians and spoliation of enormous quantities of tooling equipment and raw materials. (Footnote 1.)

Meanwhile, it would be erroneous to speak of an absolute suspension of activities : clandestinely, and at the cost of risks and considerable difficulties, the design departments continued planning the Latécoère 631, SO.30 R, Languedoc 161, etc... the flying personnel exercised their professions in Africa and in the Allied transport units. Men were constantly thinking ahead, silently planning the resumption of France's peacetime aviation.

It is worth while noting the words spoken in November, 1943, by Henry Bouché at a conference, when he also foresaw the characteristics of our present-day commercial air fleet. Incidentally, it is thanks to the work done by the *Institut Français du Transport Aérien*, which Bouché founded during the War, that, even before the hostilities had ceased, the French specialists were able to go to Chicago fully documented on the problems featured by the agenda.

> "We are convinced, meanwhile, that once the small cargo aeroplane is sufficiently advanced, companies will be established, which will prosper by exploiting the great number of advantages inherent in the transport by air of special cargo commodities ; for example : advantages of the great speed on medium distances, the quasi-elimination of packing materials, or the advantages of reducing handling to a minimum.
>
> I believe, therefore, in the progressive development of air cargo organisations which are *independent of the scheduled services*... The "flying delivery vans" will develop into "flying trucks," and will find still greater prosperity by operating hauls of 500 to 1,000 miles ; between North Africa and the Homeland, for example. It may be that their success will be enhanced by the advent of practicable *aeroplane-glider tug combinations*. After all, is there any reason why certain of these gliders could not represent the airborne counterpart of the container which private firms currently use for having their goods transported by rail and road ? I can assure you that there exist first-class firms... in France, which are preparing, already now, to have their goods shipped by air as soon as the War is over."

Briefly, the situation at the moment of the Liberation was as follows : no hard-surface runways, no hangars, few aeroplanes, few personnel, radio aids to navigation almost non-existent.

Starting from this point, we would like to illustrate the degree of reconstruction we have so far attained ; which is, to be quite truthful, but a lap along a road still full of promises : from the administrative and legal aspects, and also as regards the renaissance of ground organisation and transportation proper.

For this purpose, there must be a basis for comparison ; and this shall be French air transportation of before the War.

French Air Transportation Before the War.

Air France was founded on August 30th, 1933, by fusion of Air-Orient, Air-Union, Compagnie Générale des Transports Aériens, Compagnie Internationale de Navigation Aérienne (CIDNA), and acquisition of the assets and liabilities of the Compagnie Générale Aéropostale. It was legally registered on December 11th, 1932, when it was stipulated that the State should hold not less than 25 per cent. of the company's shares.

The Air France network extended over the entire continent of Europe (cf. table I), as well as to South America, and the Middle and Far East.

[1] The War cost French aeronautics 1,536 million francs worth of machines and tools, 595 million worth of raw materials, 4 million worth of test equipment. The useful factory area, which amounted to 30,140,000 sq. ft. in 1940, measured only 15,070,000 sq. ft. after the Liberation.

Table I. — European network : passengers and freight, from Paris to :

London (six services daily) ; Lyons—Marseilles ; Toulouse ; Strasbourg—Munich—Budapest—Bucharest ; Cologne—Berlin ; Brussels—Rotterdam—Amsterdam ; Copenhagen—Stockholm ; Marseilles—Rome ; Geneva ; Zurich ; Prague ; Warsaw ; and seasonal trips to Biarritz, Dinard, Vichy, La Baule, Cannes and Le Touquet.

Domestic network : mail.

Paris—Bordeaux—Pau (by night : Air Bleu)	representing 3,000 letters daily (2 tons)
Paris—Toulouse—Perpignan	
Paris—Clermont—Saint-Etienne—Lyons—Grenoble	
Paris—Lyons—Marseilles—Nice	

It took 1 hr. 15 mins. to fly from Paris to London, 20 hrs. from Toulouse to Dakar, 5 days to Saigon, 6 days to Tananarivo, and 4 days to Buenos Aires.

In 1939, the air fleet comprised 90 aeroplanes (against 259 in 1933), representing a daily accommodation for 1,200 passengers ; the following types featured : Dewoitine 333 and 338, Bloch 220, Potez 62, Wibault 282, Farman 2200 landplanes and Bréguet 530, LeO 242 and 246 flying-boats. Regularity on the entire network increased from 95 per cent. in 1933 to 97 per cent. in 1938 ; the safety factor was 0.08 for these six years. There were 3,800 on the payroll, of which 252 were flying personnel.

Five other companies operated alongside Air France :

Air Bleu : for domestic mail services (founded in 1937 ; 52 per cent. of the capital owned by the State).

Air France Transatlantique : for North Atlantic services (founded in 1937 ; 25 per cent. of the capital owned by the State). This company never got further than the proving and test flight stage ; the War broke out just as it was about to begin scheduled operations.

Regie Air Afrique : for the African network.

Regie Malagache : founded in 1937.

Aéromaritime : founded in 1935 ; ran a profitable business over the Dakar—Pointe Noire route, under contract to the Chargeurs Réunis transport concern.

In 1939, all these companies together possessed a fleet of 125 aeroplanes. Their tariffs were in the vicinity of frs. 2.50 per passenger-mile and frs. 3 per ton-mile.

Compared with other countries, the French position looked as follows :

Table II. — Comparison of the passenger-miles flown annually by different countries before the War.

	Passenger-miles in millions
U.S.A.	550
Germany	60
Great Britain	50
France	50
Italy	40
Holland	30

Of all these countries, only the U.S.A. and Great Britain emerged from the War with increased means at their disposal.

Administrative and Legal Aspects. Rehabilitation of Ground Organisation.

From the administrative angle, French civil aviation has been expanded in a manner consistent with its greater responsibilities since the War. The former simple Directorate within the Air Ministry has grown into a Secretariat-General, to which four Directorates report : *Transports Aériens,* responsible for economic and political questions, as well as supply ; *Navigation Aérienne,* for safety, flying personnel, airfield operations, routes, and telecommunications ; *Météorologie Nationale ;* and finally, the *Direction des Bases Aériennes,* which supervises the building of airfield buildings and runways. The Secretariat-General, headed since November 18th, 1945, by M. Max Hymans, reports directly to the Ministry of Public Works and Transport. Then, the Secretary-General has a consulting body at his disposal, the *Conseil Supérieur des Travaux de l'Air,* and is also aided by an Inspector-General for Commercial Aviation.

What was the job of the authorities ?

First of all, to put the aeroplanes into the air ; in other words, to re-open the national and international airways to French aviation. We were certainly not new to the job ; but, heritage of war, our ground organisation, like that of most other European countries, resembled an automobile built with a Ford engine, a Citroën chassis, and British accessories. Meanwhile, she has been run in, and she really does go.

Airfields.

By 1939, 50 domestic airfields had been opened to commercial services. By 1946, this figure had grown to 80. Another 21 fields were being operated overseas. And they have mounted since. To do this, it was necessary to repair and build rapidly, but far more would have been achieved if it had not been for the severe dearth of raw materials.

Table III. — Repairs and Constructions effected by January 1st, 1947.

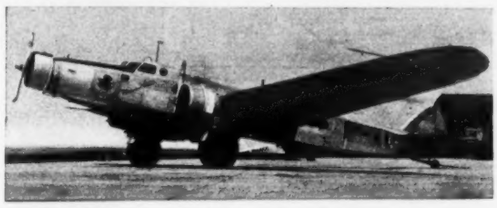
Length of repaired runways	560,000 ft.
Length of newly-built runways	72,000 ft.
Floor area of repaired buildings	7,210,000 sq. ft.
Floor area of new buildings	4,300,000 sq. ft.
Materials and working-days	50,000 tons of cement
	9,200 tons of steel
	53,000 tons of bricks and tiles
	2,350,000 working-days.

But still more remarkable than these statistics are the facts that Le Bourget airport, Paris, has been repaired and expanded, Bordeaux and Marseilles have completely new airports, and that all the major facilities are equipped with lighting installations.

At the end of 1945, only 42 airfields had been re-equipped with radio facilities. Thirty-three direction-finding stations had been re-installed. The French installations (at home and overseas), of which we may say they are improving month by month, are described summarily on the next page.

PRO MEMORIA : AEROPLANE TYPES USED BY AIR FRANCE IN 1939

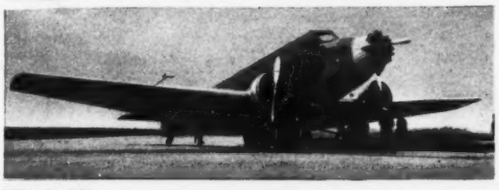
Dewoitine 333.



Dewoitine 338.

Bloch 220.

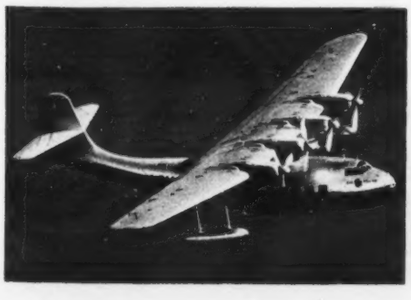
Potez 62.



Wibault 282.

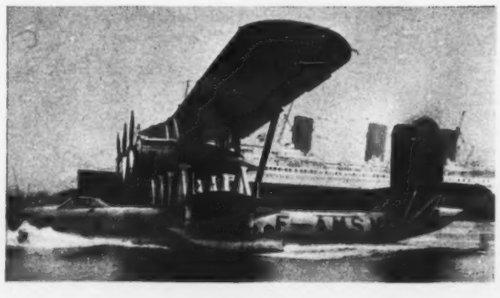
Farman 2200 South-Atlantic Mail Transport (the Model 2231 version is shown here).

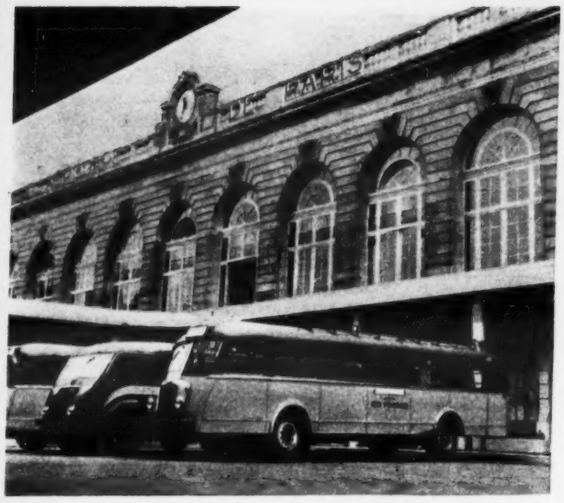
Bréguet 530.



Lioré & Olivier LeO 246.

Lioré & Olivier LeO 242.





City Terminal at Les Invalides Station, Paris.

Table IV. — Radio navigation stations put into service since the War.

Radio stations	55
M.F. D.F. stations	80
H.F. or V.H.F. D.F. stations	18
Radio beacons	12
Control towers	11
G.C.A. installations	1
I.L.S. installations	6

(I.L.S. ordered from the U.S.A. six months ago).

In all, the Directorate for Meteorology has placed more than 130 stations into service in France and her colonies.

This had to be accomplished by specialists whose ranks had shrunk considerably since 1939, so that there was the added difficulty of simultaneously having to recruit and train new personnel.

The magnitude of the task achieved is evidenced by tables V and VI, listing the personnel strengths through the years, and the traffic with which certain airports have to cope.

Table V. — Personnel strengths of the Secretariat-General for Civil and Commercial Aviation.

	1938	1945	1947
Airfields and traffic handling	113	374	1,300
Telecommunications	458	2,000	2,900
Meteorology	605	1,138	1,638

Table VI. — Weekly traffic at major airports during 1947.

		Le Bourget	Orly	Algiers	Dakar
Take-offs & landings	Winter	686	256	182	93
	Summer	1,087	195	301	102
Passengers	Winter	3,673	3,928	1,878	900
	Summer	10,069	2,341	3,387	1,270
Freight (tons)	Winter	98	70	77	40
	Summer	203	47	122	66
Mail (tons)	Winter	55	19	26	6
	Summer	51	22	28	7

Traffic is denser at Marseilles than at Orly ; at Bordeaux, Ajaccio, Nice and Lyons it is slightly thinner.

This financial load was admirably well understood, both by the general public and by the Government. The Chamber of the IVth Republic allocated 2 milliard, 658 million in 1946 and 4 milliard, 171 million in 1947 for the Civil Aviation Ordinary Budget ; and 8 milliard in 1946 and 5 million in 1947 for the Civil Aviation Procurement Budget (cf. footnote 2).

*

It appears as a paradox that the French, who pass for being conservative in their customs, and inclined towards *a priori* legislation, are content to fill transport aeroplanes notwithstanding that, since the War, this industry has had practically no solid juridical foundation. Indeed, no organic law relative to civil aviation has been voted since the cessation of hostilities. As for those of 1932, 1941 and 1943, they are in urgent need of revision.

The law on the organisation of Air France and the laws appertaining to the statutes of commercial aviation and aeronautical personnel, all in the draft stage for the past twelve months, have not yet been debated by the Chambers. The need is certainly making itself felt ; but, meanwhile, it is fortunate that the French legislator, when he is called to fill the gap, will be able to act with knowledge of the matter, profiting by the example of foreign countries, ICAO's work, and two years' practical experience "in the bargain."

[2] Taking into account the 40 per cent. reduction imposed during the current year on all French ministerial budgets.

Which, then, are the dispositions that govern the relations between the State and the airline operators, today ?

It was not until January 1st, 1946, that Air France, having assumed the title "Société nationale," shed its military trappings, worn since 1943 under the name "Réseau des lignes aériennes françaises," a military organisation not legally registered. Besides, the State's acquisition of all Air France's equipment had been sanctioned in 1944. The old company, represented by two legally-appointed trustees, is now managed in accordance with the injunction of June 26th, 1945, decreeing nationalisation of air transportation, with a managing council (Conseil de direction) nominated by ministerial decision and presided over by the Secretary-General for Civil Aviation ; it is under this regime, juridically provisional, that Air France has functioned and will continue to function until such time as the law specifying its statutes has been promulgated. The financial relations between the State and Air France are specified in a convention passed in 1946, wherein the State guarantees the carrier a minimum income on the basis of the mileage flown : this subsidy amounted to 750 million francs in 1947.

Meanwhile, in the absence of fixed statutes, the private air transport companies are also operating on a provisional legal basis.

The authorisation to operate is granted them by ministerial letter, "precarious and revocable," of which the main conditions state that "charter carriers" are forbidden to advertise their time-tables or frequencies, and to compete against Air France ; that they shall have no access to State subsidisation.

In practice, the civil aviation authorities, in the absence of a legal instrument, content themselves with impeding any scheduled transportation of passengers by air which might steal the traffic on routes operated by Air France or reserved for forthcoming operation by the national carrier. In an official speech, the Minister of Public Works and Transport outlined the policy which the Government intended to uphold in this connection : "The charter carriers shall complete, but not compete with, the regular services assigned to Air France. We shall adapt them to their specific task, but shall not tolerate the disorder which would consist in camouflaging beneath the name charter carrier, services aimed at creaming, if I may say the word, the scheduled traffic on certain routes reserved for Air France, which is and shall remain nationalised."

The debate between the upholders of this conception

Orly Overseas Airport, Paris.

and the partisans of private enterprise in free competition against the State, is bound to evince considerable interest. The latters' suggestions, which come at the farthest extremity of the combinations possible, were summarised as follows in a report to the French aviation congress in 1946 :

1. International scheduled passenger services to be operated exclusively by the national airline (except on secondary routes, each of interest to only one foreign country).

2. Competition between the national company and the private companies on the sections over French territory of international routes (obliging private companies to make intermediate stops and to abide by tariffs of at least the same level).

3. Competition between the national company and the private companies on the routes connecting different parts of the Union Française.

4. Competition between the national company and the private concerns as regards scheduled and non-scheduled freight transportation (without "dumping" on the part of the national company).

5. International services of secondary importance to be operated exclusively by private carriers.

6. Domestic services of secondary importance to be operated exclusively by private carriers.

7. Chartered services carrying passengers to be operated exclusively by private carriers (according to the definition in Chapter II, Article 5 of the Chicago Convention).

8. Every other kind of aeronautical activity to be executed exclusively by private firms.

The Re-birth of Air France.

It was with the severe handicap of a shortage of coal, steel, raw materials in general, and manpower that Air France made its great industrial effort, even before the end of the War, to regain its place. The choice lay between two policies : the one would have been to exploit "in density," that is to say, only re-activating a small number of routes, but under conditions assuring the best possible service and the highest profits ; the other, that which was pursued, aimed at the soonest possible inauguration of all routes on which French air transportation should logically figure.

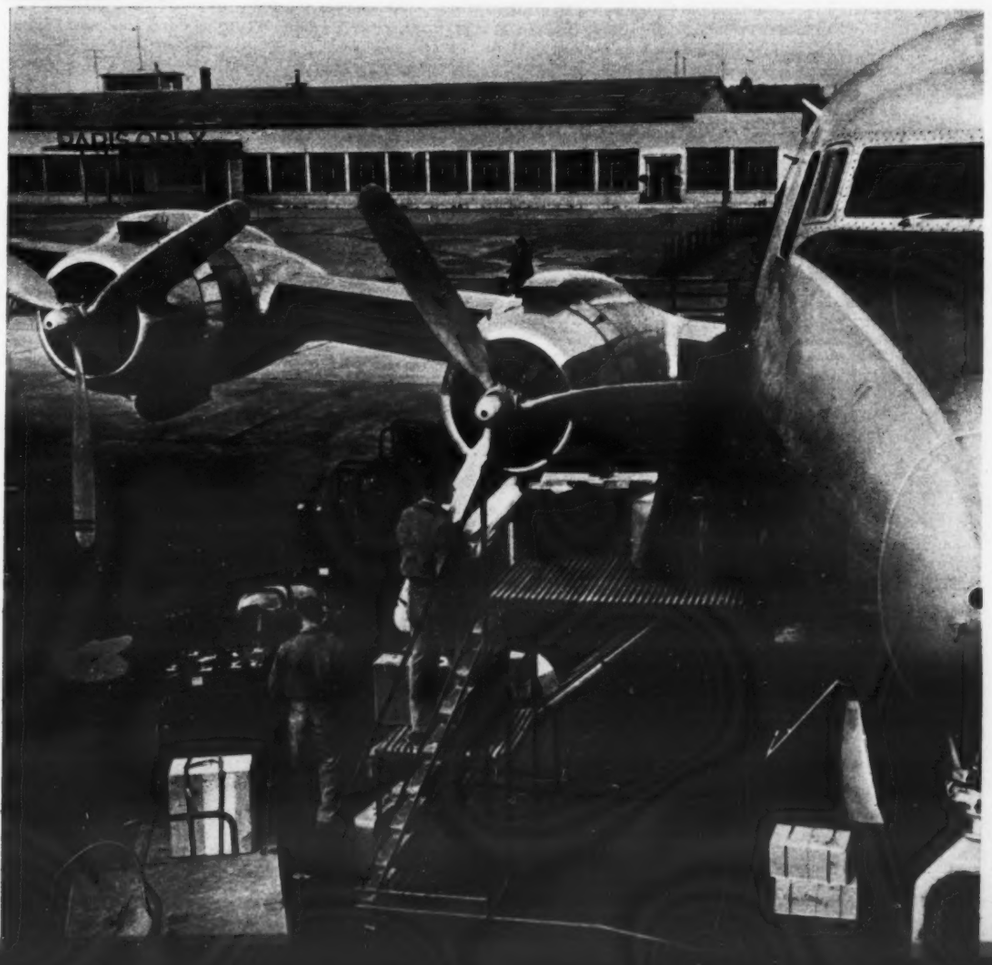
And this explains the rapidity with which its aircraft-mileage has augmented.

Table VII. — Mileage progress of Air France.

	Aircraft-miles	Passenger-miles
January, 1945 . .	300,000	1.8 million
July, 1945 . . .	750,000	6.6 million
January, 1946 . .	840,000	6.3 million
January, 1947 . .	1,260,000	17.4 million
June, 1947 . . .	1,637,000	34.2 million

The first of these two policies was the reasonable one. The other was courageous. It was indeed certain that an effort of this nature implied, during the period when it was at its most intense, and taking into account the imperatives of safety which were always respected, sacrifices as regards profits (increasing the flying equipment in order to attain a given mileage, with a relatively low rate of utilisation) as well as regularity. In the meantime, the results have manifested themselves ; and they bear witness to the sagacity of the second policy. But if the national company's network today comprises over 114,000 miles of routes, extending to every continent except Australia, it is thanks to a few men who have given proof of exceptional tenacity. Today, this pioneer work being *grosso modo* completed, we have entered the phase of perfecting : it is rather delicate for a person whose job is to inspect the airlines on behalf of the Ministry, to speak of the quality of the service offered to passengers ; anything in the nature of praise would smack of publicity... But the progress of the financial autonomy is manifested by the statistics that have been published : the State subsidies represent only 10 per cent. of the company's

Aircraft for New York now loading !
Luggage for overseas.



Elegance and comfort is a French tradition—on airliners, too.

total expenditure, against 60 per cent. in 1938/39 and 26 per cent. in 1946. As regards tariffs, Air France adheres to the international plan as formulated by IATA, and, from the national angle, to the decisions taken by the Ministry of National Economy on all transport questions. On the average, passengers are charged frs. 13.60 per mile on international routes and frs. 10.40 per mile on the domestic network; this tariff is cheaper than that charged for first-class sleeper accommodation by the railways.

It was thought that nothing could be gained by encumbering this exposé with information contained in every air guide: cities and countries served, timetables, frequencies, etc. All the same, brief mention should be made of the night mail sector connecting Paris with Casablanca and Algiers, and Paris with Bordeaux, Pau, Toulouse, Lyons, Marseilles and Nice; because this service, as obscure as it is regular, is a worthy example of what can be achieved in air transportation.

A few details on the organisation and general composition of the entire concern (personnel and equipment) will probably claim a greater measure of interest.

Every major airline company has its own scheme of organisation, though all of them bear certain similarities to each other.

That of Air France has already been altered once in the last two years; compared with the preceding one, the present scheme is remarkable for its effort to introduce method and decentralisation. For instance, a Methods Service *(Service des Méthodes)* has been set up alongside the general management, and a Psychotechnical Service (Service de Psychotechnie) to aid the personal department. In addition to being represented on the house committee normally prescribed by French law for any public or private business of major importance, the flying, ground and administrative personnel also have representatives on the managing council.

We already alluded to the state of dilapidation of the airfield facilities in 1945 and 1946, which, as may be imagined, severely affected the working conditions: Air France mechanics will not easily forget last winter at Le Bourget, when they were almost entirely exposed to the elements. But this was not the only difficulty. Just like in the Government services, it was simul-

Table VIII. **Organisation of Air France**

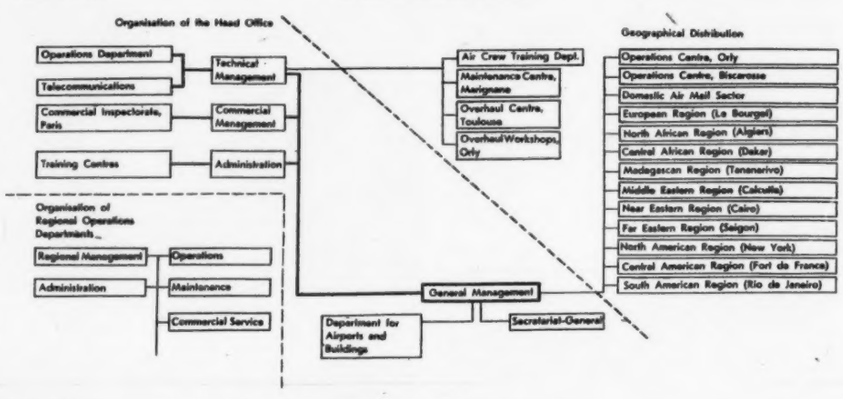


Table IX. OPERATING STATISTICS

	1938	1945	1946	1947	1st half of 1947
Network (in miles)	26,500	98,765	94,500	118,060	110,560
Aircraft-miles	6,757,350	8,364,550	14,693,200	18,641,200	8,885,600
Passengers carried	104,424	111,045	297,314	350,000	174,858
Mail (in lbs.)	1,943,840	7,520,300	9,250,200	9,920,800	5,284,000
Freight (in lbs.)	3,016,300	2,111,260	11,216,400	14,330,000	7,122,100
Passenger-miles	41,166,400	91,034,700	211,181,000	310,686,000	152,242,000
Ton-miles (mail)	696,988	1,974,641	3,011,266	3,958,140	2,027,620
Ton-miles (freight)	575,806	745,738	3,117,762	4,567,100	2,309,625

Disinfecting after overseas trip.

taneously necessary to keep business going and to recruit and train new staff. The choice of air crews was conducted on an extremely severe basis ; as regards pilots, for example, of 2,500 candidates in 1945/46, only 250 were admitted.

Regardless of their preceding training and experience, pilots have to undergo a special training course ; before they may captain a passenger airliner, they must have flown at least 30,000 miles and undergone one year of service training. At the present time, Air France has a thousand air-crew members on its payroll, of which 300 are pilots (against 365 in 1945 and 226 in 1938). Of the 9,000 non-flying personnel, 3,000 are overhaul and maintenance mechanics.

The company's flying equipment comprises the following :

46 large airliners :

13 Lockheed "Constellations" (40 seats).
15 Douglas DC-4's (42 seats).
13 Languedoc 161's (33 seats) (cf. footnote 3).
5 Latécoère 631 flying-boats (46 seats)

89 medium transports :

36 Douglas DC-3's (21 seats).
9 Lockheed 60's (14 seats).
42 Junkers Ju 52's (for mail).
2 Consolidated "Catalina" flying-boats (22 seats) ; based in the Antilles.

This fleet corresponds to a daily accommodation of 1,800 seats.

Each region has its own maintenance centre, and overhaul work is carried out at Le Bourget, Orly, Toulouse, Marignane and Algiers. Since this dispersion has not shown itself to be economical, it is planned to re-group the overhaul centres.

Standardisation with respect to equipment maintenance, and augmentation in the rate of aeroplane utilisation are the two items for which improvements must be sought energetically. It is in these two factors that lies the key to higher profits. Industrial setbacks with regard to new French equipment, as well as American, and exchange difficulties for U.S. material and hangar tooling equipment, which seriously obstructed business in 1945/46, will probably be smoothed down before long. It should be remembered that these difficulties were in no way due to any fault of the company, but were a consequence of the country's general situation.

The Rapid Rise of Private Carriers.

Fifty-two private companies have received the authority to operate in France and in the Union Française. Of these, only twenty-seven exercise any real activity. The majority have grouped to form a national charter association, the "Groupement Professionel de l'Aviation Commerciale Privée," which is a member of the International Federation of Independent Air Transport Operators. [4]

A number of these operate passenger services on a scheduled basis : in France ; from Paris to London by way of Lille ; Bordeaux to Nice via Toulouse ; Montpellier and Marseilles ; Nice to Tunis, flying by way of Corsica ; Marseilles, Nice via Calvi. In Algeria, three companies serve the sea-coast and the interior. During the first six months of 1947, one of the two largest private companies in France flew 240,000 miles, carrying 4,150 passengers ; the other flew 270,000 miles with 5,933 passengers.

Meanwhile, the mileage statistics of "scheduled private carriers," which, incidentally, have shown an excellent record of regularity and safety since the beginning of 1947, are far less significant than those of the so-called "charter companies."

The latter, numbering fourteen, transported during the first six months of 1947 : 25,000 passengers and 2,000 tons of freight over 930,000 miles.

[3] Forty on order, as well as forty 80. 30R types.
[4] "Fédération Internationale du Transport Aérien Privé," formed in 1946 with headquarters in Paris. — Ed.

Big airliners used by Air France today : Douglas DC-4's and Lockheed "Constellations."

The growth of this activity is rapid : one of them passed from 67,000 ton-miles in April to 282,000 ton-miles in July, for instance. Another, during its first six months of existence, flew 225,000 miles, carrying 277 tons of freight, 185 tons of which were for export. During the French railway strike, the private companies operated, in addition to their normal services, 470,000 passenger-miles and 2,500 ton-miles carrying newspapers.

A tendency to follow a definite traffic pattern is now clearly to be discerned in private air transportation : for passenger services, between North Africa and the Homeland ; for freight, between Africa and Great Britain, and between France and Great Britain. Only one company has specialised in taxi services ; from its base in Paris, it flew 500 trips during 1946. Then, again, certain factors which are now the object of experiments, would have been difficult to foresee two years ago : such as the importance of Perpignan as a Mediterranean terminal ; the existence of a passenger potential between West Africa and the Middle East ; non-scheduled operators' preference towards the mixed transport formula, rather than totally separate carriage of passengers and freight ; and the fact that all the busiest French air terminals, except Bordeaux, lie east of a north-south line through Paris.

Latécoère six-engined flying-boat.

Languedoc 631, developed during the War.

During their first six months of operation, the private companies flew, all together, 8.7 million passenger-miles and 1.1 million ton-miles, realising a total operating revenue of 230 million francs, without any form of State subsidy, direct or indirect. They paid 41 million in wages and brought the State in 145 million, solely in annuities on equipment. Their average tariff, on a sector like North Africa, is a little higher than Air France's for passengers (14 to 19 francs a passenger-mile) and equal to or less than Air France for freight (80 francs a ton-mile).

The flying equipment of these companies, numbering roughly a hundred aeroplanes, was originally comprised of almost only Caudron "Goélands" and Junkers Ju 52's. At present, there is a marked tendency to specialise according to the particular operation ; and many have taken advantage of the availability from surplus military stocks : DC-3's for almost all kinds of service, Handley-Page "Halifaxes" for freight, "Beechcrafts" for passenger carriage. As regards new aeroplanes, two companies have acquired Aérocentre NC. 702 twin-engined transports ; for freight or mixed transportation, the Bristol "Wayfarer" has lately acquired popularity. Understandably, the equipment acquired from surplus stocks constitutes a stop-gap solution. The private air transportation market seems to require a light twin-engined type seating six to eight passengers for feeder services, and one or two different sized cargo aeroplanes which could also be used for passengers. This is precisely why Air France is impatiently awaiting the advent of the SO. 30R, and why the private concerns have an eager eye on the development of the Dassault 315, of which the prototype has already flown, the Aerocentre NC. 211 "Cormoran," and the Bréguet 761.

Hence, despite the handicaps of the incertitude reigning as to their legal status, of having to contend with high operating costs, and of the international problem of exchange fluctuations, the French private air carriers have given ample proof of their capability : they rendered precious services by operating highly important routes between France and North Africa, and were the only carriers up to the task. Financially, they have made appreciable contributions to the State, in taxes on fuel, landings and sales ; and have aided our export drive in a big way.

They have created and developed markets which would otherwise never have seen light ; and, in the international field of competition, they are capable of matching themselves against all competitors in their category.

A Glance into the Future.

If Huxley's implication that Man's entire activity consists of transporting bits of material from one point of the globe to another, then the balance sheet of French commercial aviation certainly bears witness to a unique activity. How has France managed to furnish such an efficacious and praiseworthy effort in a field as highly complex as aviation, of which the importance does not at once strike one as being primordial ?

As was stated earlier on, this is primarily due to the men who participated : in the profession, a first-class staff of hard-working technicians and workers ; in the Government and among the public, especially among its young members, a constant spirit of encouragement towards fostering aeronautics. But, as the Ambassador of a major power once said during the war : "Moral force, good ; material force, better," this enthusiasm would not have sufficed. The really basic cause of France's aeronautical development is geopolitical. And it is a double cause. Like merchant shipping, aviation is also dependent on ports situated according to geographical and economic factors. The prosperity of merchant shipping is just as contingent on its ports as on its vessels. Well, as regards aviation, the map of the Union Française reveals that France is obliged to turn her air bases to account, even if she herself did not exercise any airfaring activity : because she is at the centre of gravity of the principal hemisphere (cf. footnote 5), because Paris is situated at a cross-roads of important West-European trade routes, because Algiers, Saigon and Dakar are French.

As for air transportation proper, it is a necessity for a country that extends its power to the African, American and Asiatic continents, that has a long Atlantic coast line and is a next-door neighbour of six other countries, Great Britain, Belgium, Germany, Switzerland, Italy and Spain, with each of which it entertains economic relations that, despite the interruptions due to the vicissitudes of history, are still active and indispensable to all concerned.

[5] Notion developed at length by the U. S. specialist, Parker van Zandt.

In a world at peace, French commercial aviation, like that of any other nationality, will not be content to stay where it is today.

On the one hand, technical progress is bound to bring about an appreciable reduction in operating costs. And it is worth while realising that a mere 10 per cent. tariff reduction per ton-mile would result in freight demands increased by a considerably higher percentage. This same progress, once the problem of regularity has been solved, will enable any centre in France to be reached within three hours. Once a passenger knows that he can leave Paris, Nantes or Bordeaux after his day's work is done, and be in Marseilles or Nice the same evening, without losing any of his accustomed sleep, there will be nothing to stop his psychology from changing completely and, in consequence, the passenger demand from attaining proportions beyond our present-day imagination. Were it not that Governments are so much harassed by other things, there might soon be a Paris—London schedule without necessity to book in advance, with police and customs formalities taking place before the departure only ; or better still, on board the aeroplane.

On the other hand, how could we know all the possibilities offered by a means of locomotion exempt of the inconveniences of having to interrupt journeys, moving in this medium that, according to Georges Cayley, is "navigable, continuous, and attains the very threshold of men's homes" ; and which benefits by the advantages of liberty of movement even more than it benefits by speed ?

From the international and inter-continental angles, the evolution will not be so rapid. Aviation, which breaks down the barriers of incomprehension and customs between nations, is likely to be the subject of official speeches for some time to come. The public has found that nations have never before been so self-centred ; people know that the exchange and police formalities have become a greater obstacle than before, to the speed of travelling by air. But there remains the fact that international air transportation has become a necessity ; and the choice of its future shape (retaining competition between nations, or forming common interest groups after the pattern of Scandinavian Airlines System, for instance) is a matter for Governments to agree on.

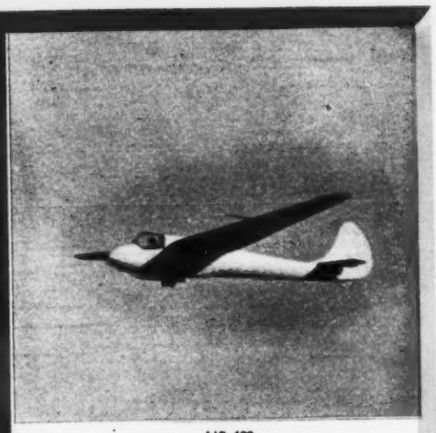
Well beforehand, however, the French Parliament will issue a law deciding the form it wishes to give to its own civil aviation activities. Solely from the standpoint of general interest, a number of solutions would be acceptable, provided that they prevent commercial aviation from becoming stagnant. Indeed, if aviation is to hold its own in the international game, it must be endowed with the necessary suppleness to go on creating new aspects. For France, it is not a vain ambition, but the achievement of a natural destiny : the vitality of her air transportation proves it.

SO. 30R "Bellatrix," of which Air France has ordered forty units.

A new French transport : Dassault 315.

Some French Aircraft Types now in Production

C. 800 GLIDER
Two-seater trainer



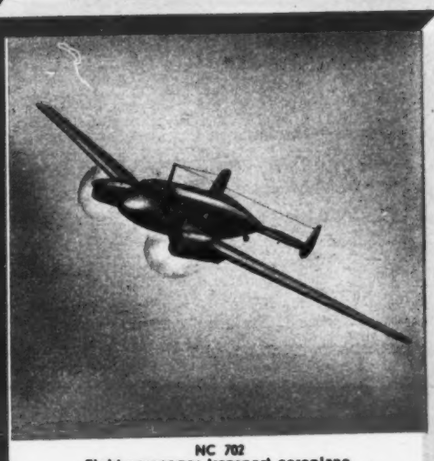
AIR 100
High-performance sailplane.

SIPA 90
Two-seater training and touring aircraft

NORD 1200 "NORECRIN"
Three-seater personal aeroplane.

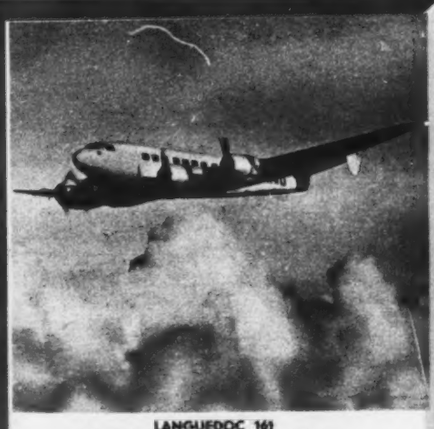
SUC 10 "COURLIS"
Taxi or personal aircraft.

MORANE-SAULNIER 472
Two-seater fighter trainer.



NC 702
Eight-passenger transport aeroplane.

SO 30 R
Modern 30-passenger airliner.



LANGUEDOC 161
Four-engined 33-passenger airliner.

LATECOERE 631
72-ton flying-boat.

OFEMA

OFFICE FRANÇAIS D'EXPORTATION DE MATÉRIEL AÉRONAUTIQUE

4, RUE GALILÉE - PARIS 16e
TELEPHONE: KLÉBER 89-10 TO 89-19
TELEGRAMS: EXAERO - PARIS

Convair XC-99

THE WORLD'S LARGEST LANDPLANE

Following the ninety-ton Northrop tailless jet bomber and the 180-ton "Hercules" flying-boat of Howard Hughes, the U.S. West Coast aviation industry has celebrated its third aerial baptism of a sky giant within two months. The youngest born of the trio is the Convair XC-99, of which the successful first flight took place on November 23rd, 1947, a Sunday, in the presence of thousands of spectators.

Though it has the same wing span and approximately the same gross weight as its 15-month-older sister ship, the Convair B-36 long-range bomber, this mammoth's 20-foot greater length and ten-foot greater height make it the world's biggest landplane. It represents five years development work on the part of Consolidated Vultee Aircraft Corp., San Diego, Cal., and an impressive capital investment of $15,000,000. At present, it is undergoing an extensive flight test programme which will probably last five months, and will afterwards be taken over by the U.S. Air Force.

This huge transport can take on a total weight of fuel and useful load amounting to 130,000 - 155,000 lbs., and the USAF will probably use it primarily for transporting material. Meanwhile, it can also haul 400 fully equipped troops over some 1,600 miles, or 200 over three times this distance, e. g., a trip from Seattle to Tokio or from Boston to Athens. As a hospital transport it can accommodate 300-odd stretcher patients with their attendants.

Just about every feature of the XC-99 prototype comes under the heading of "believe it or not," from the outer dimensions to the

One o'clock in the afternoon of November 23rd, 1947, as the XC-99 leaves Lindbergh Field's runway at San Diego and takes its first sky ride...

weights, size of separate components, fuel amounts, number of instruments on the cockpit panel and the quantities of constructional materials used. On the other hand, the combined potential output of the engines, an impressive enough figure in itself, does not appear to be extravagantly high when compared with the normal take-off weight of 265,000 lbs., not to speak of the maximum all-up weight of 300,000 lbs. with overload. At 2,700 r.p.m. the six Pratt & Whitney "Wasp Major" 28-cylinder four-row radials deliver a combined power of somewhat more than 18,000 H.P., thus a take-off power loading of 14.8 lb./H.P., which compares with a wing loading of 55.6 lb./sq.ft. A relatively long take-off distance is therefore to be expected—5,000 ft. at 265,000 lbs. all-up—and a maximum speed not exceeding 300 m.p.h. Economic cruising speed, in consequence, is not likely to exceed 250 m.p.h. Understandably, Convair is keenly interested in the current endeavours to step up the output of the "Wasp Major" and, above all, impatiently awaiting the availability of suitable airscrew-turbines in the 5,000-H.P. category.

DIMENSIONS, WEIGHTS AND PERFORMANCE.

Dimensions:

Span	230 ft.
Length	182 ft. 6 in.
Height	57 ft. 6 in.
Wing area	4,770 sq. ft.
Fuselage volume	30,000 cu. ft.

Weights:

Max. normal all-up weight	265,000 lbs.
Max. overloaded gross weight at reduced safety factor	300,000 lbs.
Empty weight, normal	135,232 lbs.
Useful load, normal	129,768 lbs.
Useful load, overloaded	155,000 lbs.

Useful load distribution:

(Estimated; data in 1,000 lbs.)

	I	*II*	*III*	*IV*	*V*
Crew of 10...	2	2	2	2	2
Cargo	100	100	44	44	12
Oil	2	4	7	7	9
Fuel	26	49	77	102	132
Useful load	130	155	130	155	155
Range (miles)	1,600	3,000	4,800	6,200	8,100

Engine power: (6 P&W R-4360-25 radials)

Take-off power without water injection:
6 × 3,000 H. P. at 2,700 r. p. m.

Economic cruising power (approx 50% at 11,500 ft.):
6 × 1,500 H.P. at approx 2,100 r. p. m.

Comparative values:

Take-off wing loading, normal	55.6 lb./sq. ft.
Take-off wing loading, overloaded	63.0 lb./sq. ft.
Take-off power loading, normal	14.9 lb./H. P.
Take-off power loading, overloaded	16.7 lb./H. P.

Performance data:

Maximum speed	over 300 m. p. h.
Economic cruising speed	approx. 250 m. p. h.
Stalling speed	93 m. p. h.
Take-off run (at 265,000 lbs.)	5,000 ft.
Service ceiling	30,000 ft.
Maximum range with reduced load	8,100 miles

Construction weights:

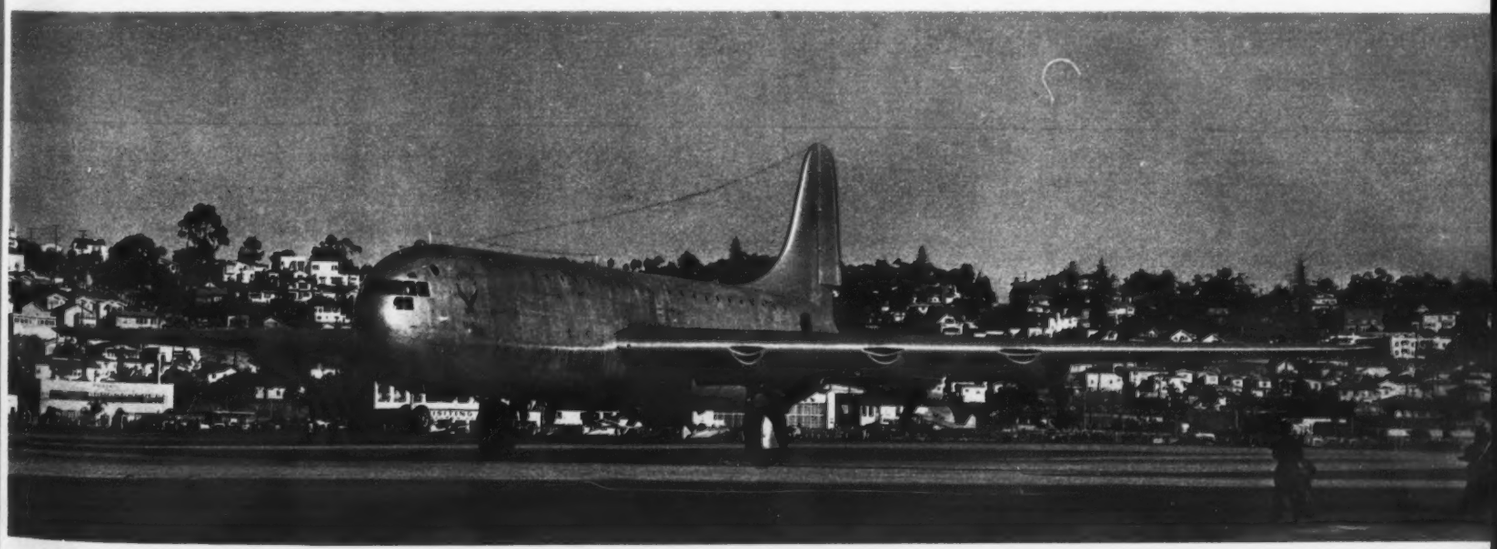
Wing (tanks empty)	37,100 lbs.
Fuselage	25,164 lbs.
Empennage	4,659 lbs.
Landing gear	18,738 lbs.
Engines plus nacelles	42,345 lbs.
Equipment	7,226 lbs.
Empty weight (sum total)	135,232 lbs.
Tank capacity (21,116 Galls.)	128,000-132,000 lbs.

Constructional Data.

The *flight deck* accommodates a crew of five, with pilot and co-pilot in the forward area and the flight engineer seated between them, slightly to the rear. The clearly set-out, though none too scanty engine control equipment is arranged so that the pilot or co-pilot could serve as flight engineer if needs be. Behind these three, on a slightly higher deck level, are the navigator (left) and radio operator (right), each provided with a table, chair and the appropriate equipment. Easy communication between crew members, already provided by the compact location of crew stations, is further enhanced by the fact that the entire flight deck is completely sound-proofed and fitted with carpets to minimise vibration: the sound-proofing and carpeting also serve as insulation for the heated cabin. The pilots' large double-pane windows, through which hot air is directed for anti-icing, feature no double curvature and give extremely good visibility. Fluorescent lighting (black) is provided at all crew stations, assuring maximum night visibility for the pilot and satisfactory lighting for other crew members. Aft of the flight deck is a bunk room for a relief crew, since the XC-99 will carry two crews on long distance operations.

The *wing* is the same as that of the B-36 long-range bomber. Spanning 230 ft., it is of marked trapezoidal form and consequently possesses sweep-back, tapering from 33 ft. 4 in. in width at the centre to 8 ft. 4 in. at the tips. The engines, distributed over about 60 per cent. of the span, are accessible during flight via a catwalk in the trailing edge. Three sets of high-lift flaps are arranged in pairs extending from the fuselage to the outboard engines. Attached to the massive ailerons are small tabs (operated directly by the pilot), which move the main surfaces by aerodynamic forces. The structural box for the wing, which extends between the front and rear spars and between the tips, utilises high-strength alloys throughout. The trailing-edge and leading-edge assemblies are of magnesium wherever possible, to reduce weight. The

... to make a perfect landing two hours later. Pilot and co-pilot were Russell R. Rogers, Chief of Flight Test and Research at Convair's San Diego Division, and Beryl (pronounced "Burl" if you please) A. Erickson, who test-flew the B-36.

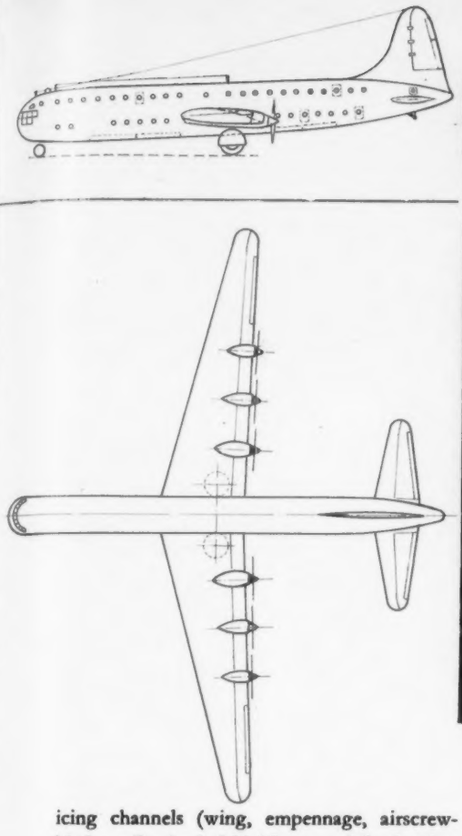


Six Pratt & Whitney "Wasp Major" four-row radials deliver a combined potential output of over 18,000 H.P. for taking off. Reversible-pitch airscrews enable the airliner to be taxied backwards or can act as brakes after landing.

entire leading edge, from fuselage to wing tip, is of double-skinned construction to permit the flow of hot air for anti-icing. Twelve compartments (six on either side), enclosed in the structure of the wing centre section, provide a total tankage of 21,116 gallons of fuel and 1,200 gallons of oil. Though the engines are usually fed from the nearest tank by means of an electrically-driven fuel booster pump, the arrangement is such that any engine can operate on any tank, or all engines on any one tank, as desired. Each tank has a direct-reading and a remote-reading fuel gauge, calibrated to indicate the exact amount of fuel remaining. A supplemental bulkhead between the inboard fuel tank and the fuselage serves as a secondary dam in the event of a fuel leakage, and prevents entry of fuel into the fuselage.

The *engines*, driving pusher airscrews via highly-reduced gears, are smoothly faired into the wing trailing edge to minimise drag. Cooling and carburretor air has therefore to be obtained through ducts from the leading edge. Since the XC-99 is required to operate at altitudes of up to 30,000 ft. or more, two turbo-superchargers are installed on each power plant. Each engine is equipped with a large cooling fan which provides sufficient cooling-air flow for all ground and flight conditions; and an automatically-controlled, ring-shaped cooling air plug, moving backward and forward between the airscrew spinner and the rear end of the nacelle, regulates air flow over the engine. By means of remotely-operated valves a part of the cooling air can be directed through heat exchangers, where it is heated by the exhaust gases before being finally ducted to the anti-

The new sky giant has a span of 230 feet...



Sister ship to the XC-99, the B-36 long-range bomber has the same wing and engines, but a shorter and narrower fuselage.

icing channels (wing, empennage, airscrew-blades, pilots' windshield) or used for heating the main cabin. Incidentally, the XC-99's heat exchangers provide 4,600,000 B.T.U. per hour, which is enough heat for a 600-room hotel. The power plants are designed on the "power egg" principle so as to provide complete interchangeability of engines, mounts and adjacent ducting.

The *airscrews,* three-bladed and nineteen feet in diameter, were designed and manufactured by Curtiss-Wright Corp. Manual pitch control, from full feather to reverse position, is provided electrically from the cockpit. Each weighs about 1,150 lbs., and as the blades are hollow they can also be anti-iced with hot air from the engines; electrical de-icing would have required too much output.

The *empennage* features truly gigantic proportions: the area of the horizontal tail, for example, is greater than the total wing area of a B-24 "Liberator" four-engined bomber. The construction method used in the tail surfaces is very similar to that of the wing (aluminium and magnesium alloys; double skin for anti-icing). The single-spar rudder and elevators are fabric-covered and, like the ailerons, indirectly controlled via a spring-tab system; a direct control system operated by muscular force would have required that the pilot have the strength of a superman. The control cables from the flight deck to the spring tabs pass through special tension-regulators in order to overcome the problem of expansion and contraction with varying atmospheric conditions.

The *undercarriage* comprises two main wheels with 110-inch Goodyear tyres, as high as the ceiling in an average home, which retract

... and measures 182 ⅓ feet in length.

Pilot "Russ" Rogers (left) with Design Engineer R. R. Hoover on the flight deck. Between the pilots' stations is the flight engineer's pedestal and seat; further aft, though not visible in this photo, are the radio operator's and navigator's stations.

inwards and upwards into the wing; a dual nose-wheel, steerable from the flight deck and also retractable, and a retractable tail bumper. A 3,000-lb./sq.in. hydraulic system actuates the undercarriage, the nose-wheel steering system and the main undercarriage brakes, the normal source of power being a 16-H.P. electric pump which can deliver seven gallons of hydraulic fluid per minute; for emergency cases, there is a hand-operated pump utilising a separate hydraulic reservoir.

The double-decked *fuselage*, of which the shape and arrangement were dictated by the versatility required of the XC-99, is of pear-shaped section, measures 20 ft. 6 in. in height along its entire useful portion, and has a maximum width of 14 ft. 3 in. The lower cargo deck, measuring 9 ft. 6 in. in both width and vertical clearance, has a reinforced floor structure for carrying highly-concentrated loads and is accessible through two openings in the bottom of the fuselage. The upper deck, which is designed to carry slightly lighter loads, measures 7 ft. 3 in. in width and 7 ft. 6 in. in height. Mobile items such as trucks and light artillery equipment can be loaded by means of ramps, suitable winches

Each of the 110-inch-high main wheels, together with its two multiple-disc brakes, weighs 4,045 lbs. Standing (left to right) are: Mel Clause, flight engineer; L. J. Bordelon and Larry C. Brandvig, power plant observers; and B. B. Gray, flight engineer, who all took part in the first flight.

Swinging this prop' is not so easy. (The Curtiss 19-foot-diameter pusher airscrews are fully controllable from feathered to reverse position. Note the ring-shaped exit for cooling air.)

being provided on the lower deck; both decks are equipped with hoists capable of handling 4,000 lbs., for loading packaged, crated and barrelled types of cargo. Two stairways and two hatches connect the upper and lower decks. [1] The two cargo doors in the bottom of the fuselage can be slid open electrically in order to permit dropping of cargo. Except for the tail cone and portions of the cargo doors which are manufactured from magnesium alloy, the entire fuselage is built of high-strength alluminium alloys in both sheet and extruded form.

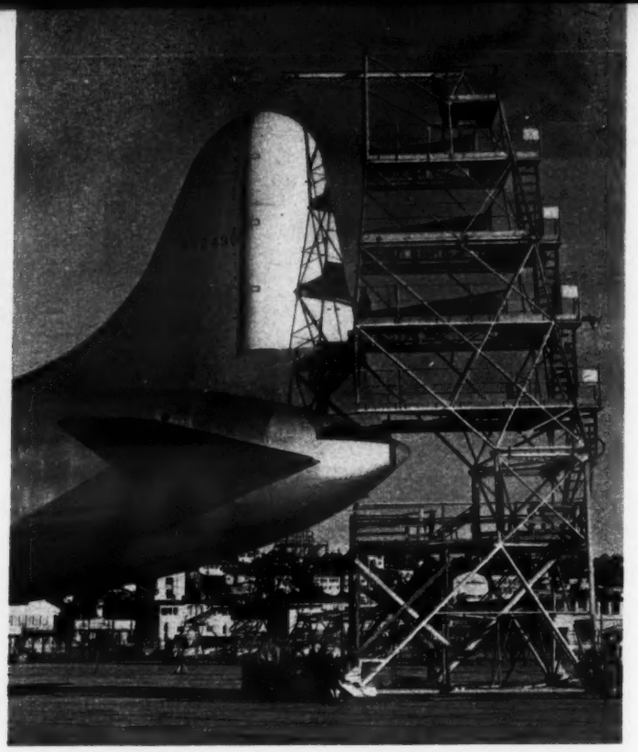
The *electrical system* has, as primary source of power for operating all equipment, a 208-volt, 400-cycle, three-phase, alternating-current system powered by two main engine-driven alternators and one accessory engine-driven alternator. The three-phase current allows light-weight induction electric motors to be used instead of commutator types and thus eliminates the necessity for close maintenance of brushes and removes the arcing difficulties normally encountered at high altitudes with brush-type motors. The relatively high voltage power has enabled small-gauge wire to be used as well as light-weight motors, which, in view of the 25 miles of wiring and the numerous uses for electricity on the XC-99, all makes for substantial weight saving. Wherever required, the three-phase current can be split up into 110-volt, single-phase circuits or else transformed into direct current. For intra-plane communication there is a low-voltage circuit working a 12-station inter-phone system; one such station is located in each engine nacelle.

[1] "INTERAVIA, Review of World Aviation" Vol. I, No. 4, P. 76.

Part of the upper deck. Rollers are provided at each of the fuselage frames, while the hoist itself provides the rolling surface, or rail for traversing of the hoist.

The rear opening to the lower deck, and the electrically-operated sliding doors which may also be opened in flight.

Maintenance can be quite a problem: changing an airscrew calls for a special crane.



Another maintenance problem: it needs a scaffolding as high as a fifth-floor window to get at the empennage.

The longe-range civil transport of tomorrow?

One-time optimism concerning the XC-99's early utilisation as a long-range airliner —one spoke of 204 passengers, six 5,000-H.P. airscrew-turbines and a cruising speed of 340 m.p.h.—has yielded to more critical opinions. First of all, the ground installations for this sky mammoth cost a great deal. The minimum runway, 8,400 ft. according to C.A.A. regulations, has to be built of highly-reinforced concrete, since the static wheel-pressure alone amounts to over 130,000 lbs. The reader can form his own idea of the dimensions of the hangar. The maintenance problems to be solved and the costs they will incur may be deduced from the accompanying photographs.

Even the air force of an important country like the U.S.A. can scarcely shoulder such an expenditure without weighing the consequences, but no Government authority will want to work out exactly how much more is to be gained by stopping a war than by losing a war. On the other hand, a more critical standpoint will have to be taken by airport administrations in the calculation of landing fees and by airline companies in the compution of flying costs — since the aim in both cases is to balance the expenses and the income. A safe opinion is that, for carrying the bulk of commercial aviation, the airline companies will not acquire aeroplanes exceeding the size of the Lockheed "Constellation" and Douglas DC-6 for many years to come. Even the 130,000-lb. Boeing "Stratocruiser," in view of its enormous wing loading, requires inconveniently-long runways.

In contrast, it is not excluded that between airports like Idlewild at New York, Orly near Paris and London's Heathrow, which would naturally have to be suitably expanded and equipped, an inter-continental shuttle service might be operated with the XC-99 —which would then be known as the Convair 37—as soon as the new power plants make this possible technically. *Ri.*

Fitted with six airscrew-turbines of 30,000-H.P. combined power, the XC-99 could transport 204 passengers in 9 hours from New York to London or Paris... runway permitting.

Aeroplane Drag When Approaching Sonic Speed

By W. Just, D.Sc., and K. Sahliger, B.Sc.

The significance of the aeroplane as the fastest means of transport has entailed that the urge to increase its speed will never cease. Every aspect of research is being brought into play in order to attain this ever-constant goal. Thus a continual search has been going on, roughly parallel to that for increased engine output, for forms causing the least drag. Economies were made by reducing the frontal area, by rejecting the wire-braced multiplane of World War I for the higher-performance cantilever monoplane, by cutting down drag due to undercarriage, etc., and by improving surface quality with careful machining and fairing; so that the aeroplane of today seems to represent a well-advanced stage of development. A further successful step was taken when, after intensive research on boundary layer, engineers discovered how to develop aerofoils with drag coefficients considerably below those of previously-existing designs. These are the now-familiar laminar-flow aerofoils, which were developed to a particularly high level in the U.S.A. As is known, there is laminar boundary layer in the forward part of an aerofoil, which, downstream of a certain point, the so-called point of transition, changes into turbulent boundary layer. Since the turbulent boundary layer causes considerably more drag than the laminar, the position of the point of transition is of importance as regards the drag of an aerofoil. The advantage of laminar-flow aerofoils is that the point of transition is relatively far downstream, even at high Reynolds Numbers, so that the drag also remains low at high Reynolds Numbers. The first successful practical application of such aerofoils was made on the well-known fighter aeroplane of the last war, the North American P-51 " Mustang. "

Whilst the new aerofoils enabled maximum speeds of 700-800 km/h to be obtained with piston engines and airscrews, the advent of jet propulsion has permitted flying speeds to be increased by leaps and bounds, in contrast to the previous steady increases. In consequence, the speed of sound (1,225 km/h at sea level) has been approached relatively quickly, a circumstance which has brought entirely new aerodynamic problems to light, which had previously been of significance only in connection with the tips of airscrew blades and in the field of ballistics. The fact that, when sonic speed is approached, at about 900 km/h, for instance, the aerodynamic behaviour is subjected to major and sudden changes, causing sharp increases in drag, for example, and very sudden moment modifications, has set engineers the task of postponing these disturbances until the highest possible speeds have been reached, thus to discover the most favourable forms for the individual components such as wing, fuselage and nacelle, in order to mention the most important ones, and how to assemble them. Already whilst in the field of low speeds, engineers were greatly dependent on measurements; and today, since the compressibility of the air has assumed such decisive importance, they are dependent on measurements to a far greater extent, all the more because theory has not been able to keep pace with the speed of development.

In order to explain the Mach behaviour with regard to the increase in drag, a number of systematic measurements relative to wings, fuselages and nacelles are described in the paragraphs below, thus giving a few directives as to the way ahead.

Wing

For investigating the Mach influence on the wing, we can consider the latter's planform and profile separately. Theoretical studies have shown that, from the Mach viewpoint, a three-dimensional flow presents more advantages than a two-dimensional flow. Because, figuratively speaking, the air can deviate in two coordinate directions, small increased velocities arise. Since at larger aspect ratios, approximately from $\Lambda = b^2/F$ amounting to over 5, we are faced with a primarily two-dimensional problem, there is a possibility of increasing the critical Mach Number, thus the Mach Number at which the drag increases suddenly, by reducing the aspect ratio. For example, at an aspect ratio of $\Lambda = 5$ a critical Mach Number $M_{kr} = 0.74$ occurs and at $\Lambda = 1.1$, one of $M_{kr} = 0.8$, which corresponds to a possible speed gain of about 75 km/h at sea level. A similar effect to that produced by reducing the aspect ratio can be achieved by giving the wing sweepback. At an aspect ratio of $\Lambda = 6$, for instance, an angle of sweepback of $\phi = 35$ deg. gives rise to a Mach gain of 0.08, corresponding to a speed increase of 100 km/h; for more information in this connection see [1], * where the influence of sweepback is dealt with extensively, so that it would be superfluous to treat the wing shape in any detail in this article.

As stated above, the profile of the wing also has a great influence on the Mach behaviour. As later on measurements on various aerofoils will be mentioned, here are a few words on the geometry and symbols relative to the aerofoils under consideration. Thus, according to the nomenclature introduced by the Deutsche Versuchsanstalt für Luftfahrt (DVL), which is built up on the NACA system [2]:

$$\text{NACA}_{\text{E}}\ 2\ 35\ 12 - 0.55 - 40$$

NACA_{E}	2	35	12	— 0.55	— 40
Developed NACA streamlined bodies	Camber f/l %	Camber position ξ_f %	Thickness δ %	Index of leading-edge radius ρ_{KZ}	Thickness Position ξ_δ %

* The numbers in rectangular brackets apply to the references.

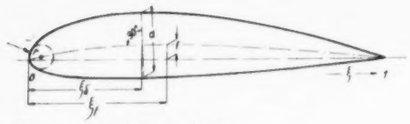


Fig. 1 : Aerofoil symbols.

The symbols are explained in Fig. 1.

With ρ_{KZ} the leading edge radius is :

$r = \rho_{KZ} \cdot (\delta)^2 \cdot t$; $\rho_{KZ} = 1.1$ in normal NACA aerofoils ; $\delta = d/t$

The airflow velocity v_0 very far in front of an aerofoil is accelerated by the latter to a maximum value v_1 on the profile contour. For an elliptical wing section, v_1 can easily be calculated to :

$$v_1 = v_0 (1 + \delta)$$

where the maximum increased velocity is $\Delta v = v_0 \cdot \delta$. If v_1 exceeds sonic speed, then the supersonic speed does not go over steadily into subsonic speed, but in the form of a shock wave which can entail laminar-turbulent transition on the aerofoil and, consequently, a sharp increase in drag. Details on the formation of the shock wave are contained in [3]. We shall now term as v_a, that speed at which sonic speed a is attained at any point on the aerofoil, thus $v_1 = a$ as the critical airflow velocity ; and call the corresponding Mach Number the theoretical critical Mach Number, or symbolically, $M_a = v_a/a$. Measurements have shown that this number M_a in no way represents the Mach Number at which the sharp increase in drag begins. As already mentioned above, the increase in drag is due to the fact that the boundary layer cannot hold out against the sudden increase in pressure caused by the shock wave, and breaks down. It may be deduced, therefore, that the occurrence of a shock wave must not always cause the lamina to break down, but that a certain sudden jump in pressure, or a pressure shock, must first be coupled with the adjacent boundary layer in order to achieve this result. Thus it can occur that very great increased-velocity peaks form, which, at very far upstream positions, do not lead to a breakdown in flow, since the boundary layer is still relatively thin towards the front of the aerofoil. It may furthermore be seen that the quality of an aerofoil as regards the practical critical Mach Number M_{kr} at which the drag rise is in reality initiated, can in no way be judged solely by the magnitude of the maximum increased velocity. Within certain limits, the definition of the critical Mach Number M_{kr} is only arbitrarily possible ; thus, for instance, M_{kr} has been defined as the Mach Number at which the drag is 10 per cent. higher than that at $M = 0.5$. Meanwhile, it has been found more convenient to define the critical Mach Number as being that at which the drag increase features a certain gradient ; and in this study, we shall define M_{kr} as the Mach Number at which the c_w-increase over Mach assumes the value $\frac{\partial c_w}{\partial M} = 0.02$.

Influence of Thickness

As already inferred above, in elliptical profiles the increased velocity is proportional to the thickness ; which condition is also approximately valid for conventional profiles. In Fig. 2, the drag coefficient is plotted against the Mach Number for the 0 00 δ — 1.1 — 30 aerofoil, thus the conventional symmetrical aerofoil, with $c_a = 0$. It is clearly to be seen here that the practical critical Mach Number M_{kr} decreases as the aerofoil thickness d/t increases. Also plotted are the Mach Numbers M_a at which sonic speed a is just attained locally ; these were obtained from pressure-distribution measurements. The critical Mach Numbers M_{kr} were obtained from the corresponding curves for other c_a-values with the help of the condition $\frac{\partial c_w}{\partial M} = 0.02$, and plotted in Fig. 3. At small c_a-values, roughly up to $c_a = 0.4$, a superiority of slender aerofoils decreasing with c_a is to be observed, whereas at higher c_a-values the thicker aerofoils are more advantageous since, at higher values of c_a, thick aerofoils feature smaller increased velocities because of their greater leading-edge radii $r/t = 1.1\ (\delta)^2$. The curves relative to the 1.8 15 δ — 1.1 — 30 aerofoil (usual NACA designation : 230 δ), ordinarily employed at low speeds, are plotted in Figs. 4 and 5. It can be seen that a small camber of 1.8 per cent. for otherwise the same aerofoil alters the character of the curve to a relatively great extent. Whereas in symmetrical aerofoils (Fig. 3) a strong influence of aerofoil thickness is ascertainable, exercised differently at small and large values of c_a, the case of the cambered aerofoil (Fig. 5) evidences no great dependence of the critical Mach Number M_{kr} on the thickness in this connection. Up to $c_a = 0.6$ the symmetrical aerofoil of equal thickness is superior to the cambered type. Further details on the influence of camber are given below.

Position of Maximum Thickness

That smaller increased velocities occur on aerofoils with the maximum thickness positioned aft than on types with the maximum thickness well upstream, is evident from the following simple explanation : in great approximation, we can replace the profile from the leading edge to the point of greatest thickness, thus to ξ_δ (Fig. 1), by a half ellipse whose ratio of thickness to length is $\frac{\delta}{2\,\xi_\delta}$, thus decreasing as the position of maximum thickness shifts downstream, with the thickness remaining the same. According

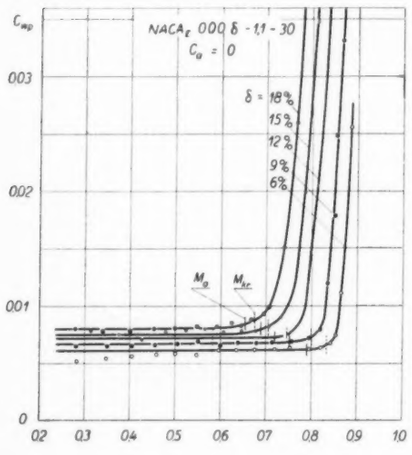


Fig. 2 : Drag versus Mach Number for symmetrical aerofoils with thicknesses δ = 6 to 18 per cent.

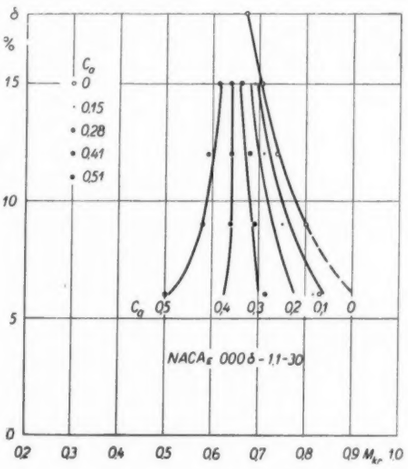


Fig. 3 : Critical Mach Number M_{kr} for symmetrical aerofoils plotted against aerofoil thickness δ at different c_a-values.

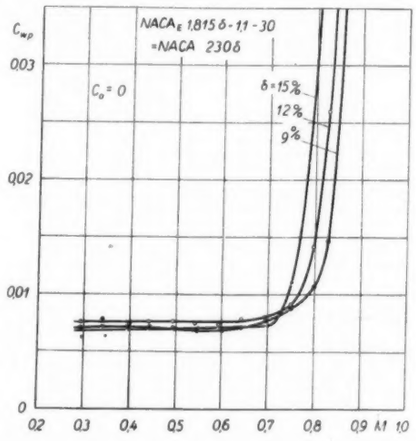


Fig. 4 : Drag versus Mach Number for aerofoils of the 230 δ-series with thicknesses δ = 9 to 15 per cent.

to the afore-mentioned formula for increased velocities on ellipses, the increased velocity also decreases on the aerofoil, whereupon the critical Mach Number increases as the point of maximum thickness shifts downstream. In Fig. 6 the profile drag with $c_a = 0$ is plotted against the Mach Number for a symmetrical aerofoil with $\delta = 12$ per cent. and $\rho_{KZ} = 0.55$ (half-normal leading-edge radius) for three positions of maximum thickness, $\xi_\delta = 30$, 40 and 50 per cent. It is clearly seen that M_{kr} increases as the position of maximum thickness is shifted downstream. The corresponding curves for $c_a = 0.4$ are contained in Fig. 7. Conspicuous here is the great difference between the theoretical Mach Number M_a and the practical M_{kr}. Whereas in the aerofoil with $\xi_\delta = 30$ per cent., M_a and M_{kr} are near to identical, their difference increases to $M_{kr} - M_a = 0.3$ as the maximum thickness shifts downstream to $\xi_\delta = 50$ per cent. It is furthermore to be seen that, despite the decrease in M_a, M_{kr} can increase still more. To reiterate, therefore, it is by no means the increased velocity alone which governs the Mach behaviour of an aerofoil. The conspicuous character of the c_w-curve for the position of maximum thickness $\xi_\delta = 50$ per cent. is caused by the fact that, after the initial breakdown at $M = 0.6$, the airflow becomes laminar again as the velocity increases, owing to the special form of the pressure distribution, pressure drop and, therefore, acceleration of the boundary layer behind the shock wave (Fig. 7 *b*) ; at increasing Mach Numbers, this case becomes all the more evident owing to the ever-increasing pressure-drop aft of the shock wave. Since, moreover, the shock wave generally shifts downstream as the Mach Number increases, but the point of laminar-turbulent transition as a rule lies in the vicinity of the shock wave owing to the almost constant pressure distribution in front of the shock wave, forming because of the supersonic speed (cf. also Fig. 16), a longer laminar portion of boundary layer can build up as the Mach Number increases, and the drag can decrease. From further curves for other c_a-values, the M_{kr}-values were obtained, and plotted in Fig. 8 against the position of maximum thickness ξ_δ. It is discernible that at upstream positions of maximum thickness, small c_a-values are more advantageous, whereas at $\xi_\delta = 50$ per cent., the c_a-influence almost disappears. The final conclusion to be drawn is that aerofoils with their point of maximum thickness far downstream, which, as laminar-flow aerofoils, are known to feature particularly low drag coefficients at normal speeds, are also the most suitable types for obtaining very high speeds.

Leading-Edge Radii

Fig. 9 shows the c_w-values for normal, ¾- and ½-normal leading-edge radii, corresponding to the three leading-edge-radius indices $\rho_{KZ} = 1.1$, 0.825 and 0.55, for a symmetrical aerofoil with 12 per cent. thickness and maximum thickness at 40 per cent. chord. As can be seen, the influence is not very significant. Not until higher c_a-values are attained does the utilisation of more pointed leading edges present an advantage (Fig. 10). Meanwhile, the leading-edge radius has a greater influence on the $c_{a\ max.}$ of an aerofoil. Fig. 11 shows the curve of $c_{a\ max}$ for the same aerofoil with an without split-flap, plotted against ρ_{KZ}. The aerofoil with normal leading-edge radius $\rho_{KZ} = 1.1$ is clearly the best. It should be noticed, however, that for achieving an advantageous profile with the point of maximum thickness far downstream, it is absolutely necessary to have a small leading-edge radius. The engineer will therefore

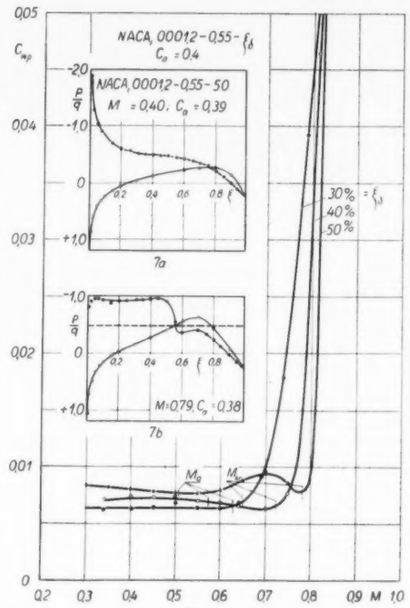


Fig. 6 : Drag versus Mach Number for symmetrical aerofoils with positions of maximum thickness $\xi_\delta = 30$, 40 and 50 per cent. at $c_a = 0.4$
a) Pressure distribution p/q at $M = 0.40$
b) Pressure distribution p/q at $M = 0.79$
• Upper surface ◦ Lower surface

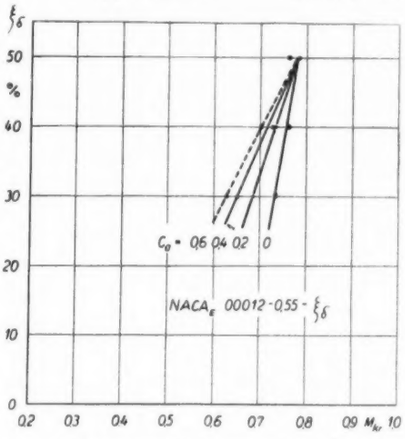


Fig. 8 : Critical Mach Number M_{kr} for symmetrical aerofoils plotted against position of maximum thickness ξ_δ for different c_a-values.

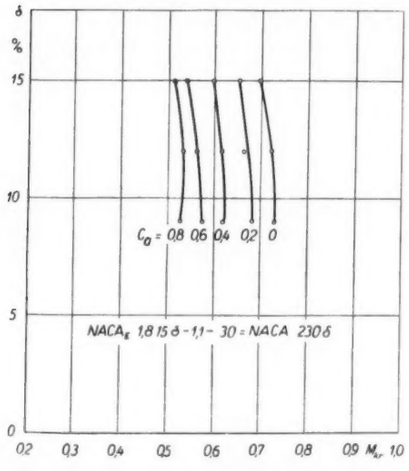
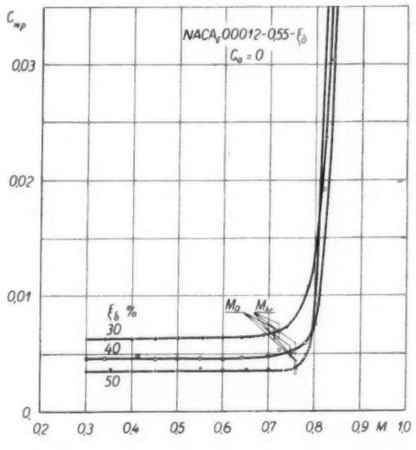


Fig. 5 : Critical Mach Number M_{kr} for aerofoils of the 230 δ-series plotted against aerofoil thickness δ at different c_a-values.



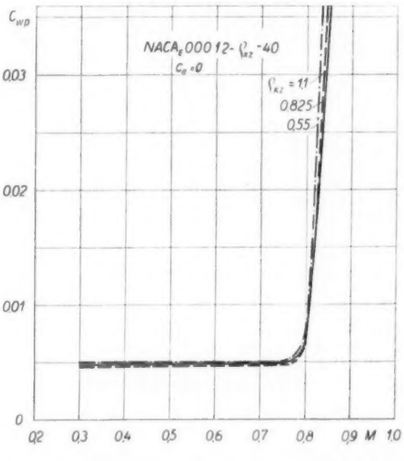


Fig. 9 : Drag versus Mach Number for symmetrical aerofoils with normal, ¾-normal and ½-normal leading-edge radii ($\rho_{KZ} = 1.1$, 0.825 and 0.55).

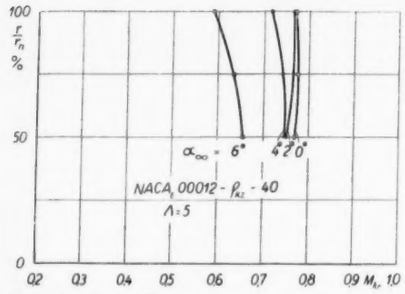


Fig. 10 : Critical Mach Number M_{kr} for symmetrical aerofoils versus leading-edge radius in percentage of normal leading-edge radius γ_n for different angles of incidence.

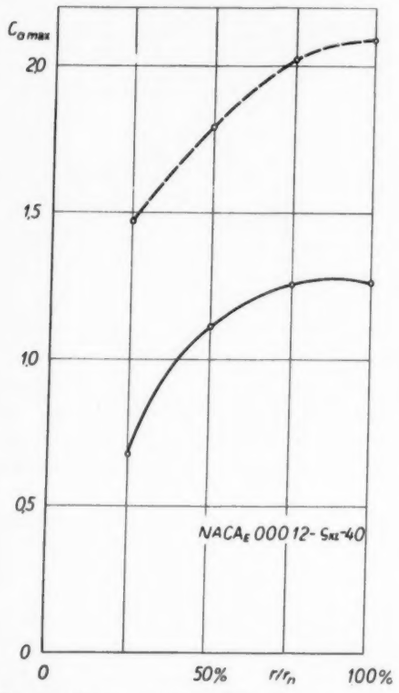


Fig. 11 : Maximum lift coefficient $c_{a\,max}$ versus leading-edge radius.
Without flaps ———, with split flaps — — — —.

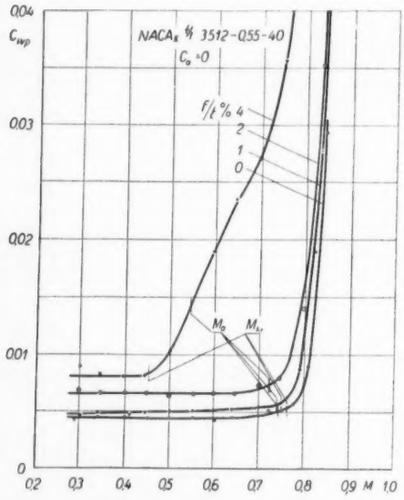


Fig. 12 : Drag versus Mach Number for cambered aerofoils with cambers f/t from 0 to 4 per cent. at $c_a = 0$.

have to find the most favourable compromise, according to the specific requirements. It may also be mentioned in this connection that, by suitably distributing the leading-edge radii along the span, the initial transition can be controlled within certain limits and the stall behaviour can consequently be influenced for the better.

Camber

The influence of aerofoil camber on the drag curve at high Mach Numbers is discernible from Figs. 12 and 13, where the measurements at $c_a = 0$ and $c_a = 0.4$ are plotted for aerofoils with maximum camber at 35 per cent. chord, with 12 per cent. thickness, ½-normal leading-edge radius and maximum thickness at 40 per cent. chord, with the cambers $f/t = 0.1$, 2 and 4 per cent. For $c_a = 0$ (Fig. 12) the symmetrical aerofoil is of course the most advantageous, since at this c_a-coefficient additional increased velocities must arise owing to the camber. For small c_a-values, the cambered aerofoil is never used, even at small speeds, simply because of its high drag coefficient. At high c_a-values, however, cambered aerofoils (camber usually at 2 per cent.) have always been used, since at low speeds they are more advantageous from the point of view of drag (cf. also Fig. 13 at low Mach Numbers). But there, too, we see that, as regards M_{kr}, the symmetrical aerofoil is superior to the conventional type. Because a symmetrical aerofoil features greater increased velocities at high c_a-values than a cambered aerofoil, it is often erroneously assumed that it must also be inferior from the Mach viewpoint. However, as mentioned at the beginning of this article, it is not the maximum velocity that is of significance, but the entire curve of the velocity along the profile contour, as this governs the boundary layer. However, the inference may not be drawn from the aerofoil under examination, that cambered aerofoils are always inferior to symmetrical ones at high c_a-values. It is to be assumed that aerofoils featuring little camber and accordingly-regulated thickness distribution can also produce good results. In Fig. 14, the critical Mach Number is again plotted against the camber for a constant value of c_a. Here, too, the superiority of the symmetrical aerofoil at all values of c_a is clearly recognisable for the aerofoil in question, and that the decrease of the critical Mach Number owing to higher c_a-values is independent of the camber for the usual cambers of f/t up to 2 per cent.

In order to show the relation between *pressure distribution* and Mach Number, Fig. 15 uses the NACA$_E$ 1.8 15 15 — 1.1 — 30 aerofoil, thus the usual NACA 23015 (for which the curve of drag versus Mach Number is also shown in Fig. 4) to indicate the pres-

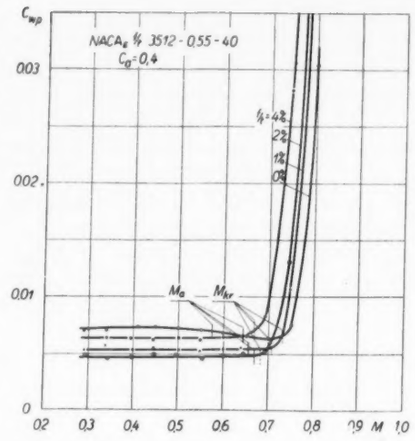


Fig. 13 : Drag versus Mach Number for cambered aerofoils with cambers f/t from 0 to 4 per cent. at $c_a = 0.4$.

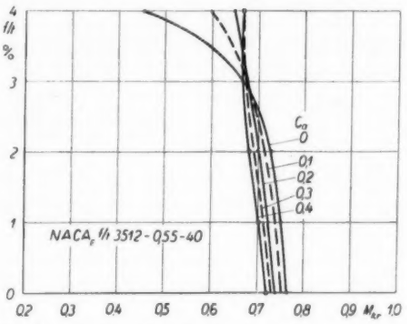


Fig. 14 : Critical Mach Numbers for cambered aerofoils versus camber f/t for different c_a-values.

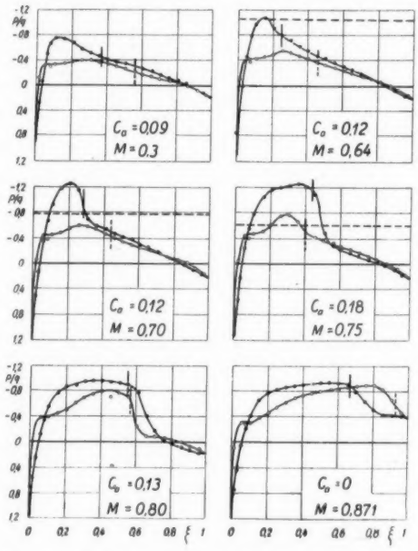


Fig. 15 : Pressure distribution for the NACA$_E$ 1.8 15 15 - 1.1 - 30 aerofoil, corresponding to NACA 23015, for Mach Numbers $M = 0.3$ to 0.871.

- • Measurement point on upper surface
- | Point of transition on upper surface
- ◦ Measurement point on lower surface
- ¦ Point of transition on lower surface
- ——— Sonic speed limit

sure distributions at different Mach numbers, namely from $M = 0.3$ to 0.87, and at an angle of incidence α_∞ of about 0 deg. The pressure distribution at $M = 0.3$, which roughly corresponds to that calculated, with the compressibility disregarded, changes up to $M = 0.64$ in accordance with Prandtl's theory only; the total pressures, thus the c_a too, increase somewhat, whilst the overall picture remains similar. At $M = 0.64$ it is to be seen that the minimum pressure corresponding to the highest velocity occurring on the aerofoil attains such magnitude that at this point v_1 is equal to sonic speed a (– – – line). At $M = 0.7$, the pressure on the suction side rises sharply at $\xi_\delta = 0.3$; at this point the supersonic goes over into the subsonic speed, and the afore-mentioned shock wave enters the picture. At this Mach Number the laminar boundary layer has already broken down and M_{kr}, amounting roughly to 0.67, has already been exceeded. As the Mach Number increases (see further Figs.) the shock wave shifts further downstream. On the lower side the shock wave only occurs at higher Mach Numbers, at about $M = 0.75$. By means of tests with the airflow made visible, the point of transition between laminar and turbulent boundary layer could also be observed for different Mach Numbers, and presented graphically. It can be seen that owing to the increase of the Reynolds Number between $M = 0.3$ and 0.64, corresponding to the M-increase, the point of transition, at the same distribution of pressure, generally shifts upstream. At higher Mach Numbers, however, the pressure distribution changes in front of the shock wave; in front of the latter no noticeable rise in pressure occurs to the detriment of the boundary layer, so that the point of transition shifts downstream with the shock wave. It is to be seen that at $M = 0.871$ the point of transition has shifted up to $\xi_\delta \approx 65$ per cent., which, in contrast to the case discussed in the chapter on the position of maximum thickness, has no practical significance in this instance, since the airflow has already broken down aft of the shock wave.

Fuselage and Nacelles

As mentioned above, a three-dimensional airflow about an aerofoil is more advantageous as regards increased velocities and consequently Mach behaviour, too, than a two-dimensional flow, if, for instance, the same ratio of thickness to length is presupposed. It is also for this reason that, until recently, engineers had not conducted such intensive high-speed research on fuselages and nacelles, as on wings, since the previously-used wing plan-forms and profiles featured considerably lower critical Mach Numbers than fuselages and nacelles. Meanwhile, owing to the development of high-speed profiles combined with suitable wing plan-forms, such as those with sweepback and extremely low aspect ratios, the critical Mach Numbers for wings were raised to such a level that they came within the range of the critical Mach Numbers for conventional fuselages (and nacelles). The necessity arose, therefore, also to subject the fuselages to systematic measurements which, because of the low fuselage drag and the fact that the ordinary suspended models featured lower critical Mach Numbers than the actual fuselages to be measured, presented particular technical difficulties. A series of measurements executed on fuselages representing solids of revolution are grouped in Fig. 16; if we are to retain the symbols pertaining to streamlined bodies, these measurements are for a position of maximum thickness of $\xi_\delta = 40$ per cent. and a thickness of $\delta = 10$ to 40 per cent. Small Mach Numbers illustrate the familiar circumstance that streamlined bodies with $D/L = \delta = 20$ per cent. feature the lowest $c_{w\varphi}$ (drag coefficient based on the maximum frontal area $F\varphi = \frac{D^2\pi}{4}$).

At high speeds, the fuselage with the lowest thickness ratio, $D/L = 10$ per cent., is the most advantageous. Fig. 17 presents the drag curve for a series of relatively thick streamlined bodies, which could be taken to represent nacelles, for instance, with $D/L =$ 36 to 44 per cent. and positions of maximum thickness of $\xi_\delta = 36$ to 22 per cent. Whereas the fuselage measured in Fig. 16 corresponds to the conventional NACA streamlined bodies for aerofoils [2], the system applying to Fig. 17 was set up by retaining the NACA streamline shape aft of the point of maximum thickness, and substituting a semi-ellipsoid of revolution for the forward portion. The fuselage featuring the smallest thickness and simultaneously the farthest downstream position of maximum thickness is, of course, the most advantageous. Fig. 18 again shows the critical Mach Numbers, defined here by $\frac{\partial c_{w\varphi}}{\partial M} = 0.1$, from Figs. 16 and 17, plotted against the thickness ratio. It is evident that, as already mentioned, low thickness ratios are advantageous. Moreover, it may be deduced from the curve derived from Fig. 16, that the critical Mach Number increases as the position of maximum thickness shifts downstream, and from the position of the two curves to one another, that the elliptical nose is more advantageous than the conventional NACA streamlined body. For purposes of comparison, Fig. 18 also contains the values relative to the smooth model-fuselages of the Me 262 and Ar 234 aeroplanes. Owing to their dissymmetry and imperfect streamline forms they are inferior to the fuselages featured in the systematic measurements.

Entire Aeroplane

Now that the drag relative to isolated wings, fuselages and nacelles has been dealt with, a number of measurements will serve to show how the drag, and particularly the critical Mach Number, is influenced by the interferences arising when these parts are

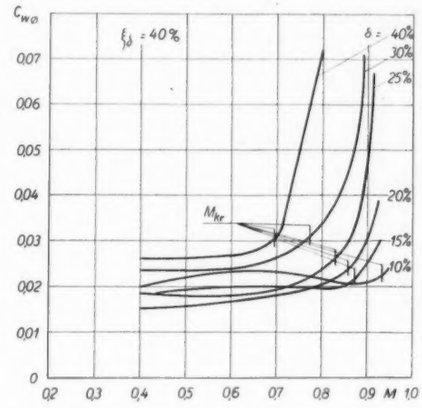


Fig. 16: Drag versus Mach Number for streamlined bodies with position of maximum thickness $\xi_\delta = 40$ per cent. and thicknesses $\delta = 10$ to 40 per cent.

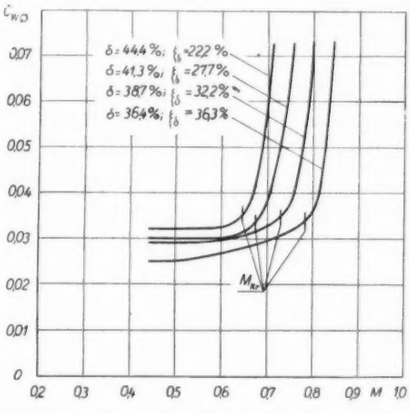


Fig. 17: Drag versus Mach Number for streamlined bodies with different elliptical nose portions and same tail portion for positions of maximum thickness $\xi_\delta = 22.2$ to 36.3 per cent. and thicknesses $\delta = 44.4$ to 36.4 per cent.

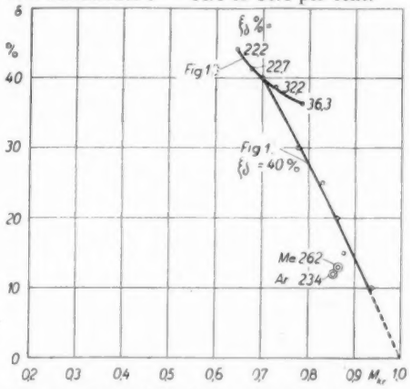


Fig. 18: Critical Mach Numbers for fuselages in Fig. 16 and 17, plotted against fuselage thickness δ.

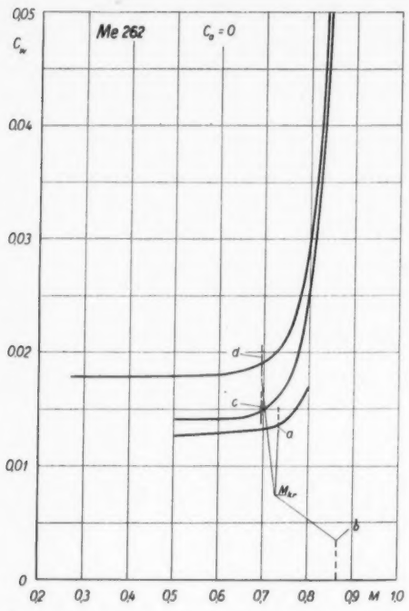


Fig. 19 : Me 262 : Drag versus Mach Number for a) wing alone, c) entire model without nacelles, d) entire model. b) Critical Mach Number of fuselage.

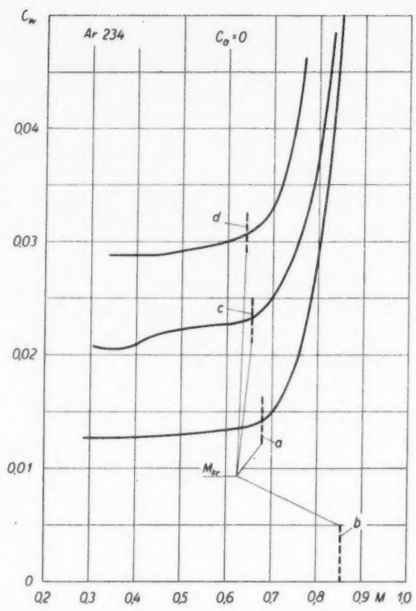


Fig. 20 : Ar 234 : Drag versus Mach Number for a) wing alone, c) entire model without nacelles, d) entire model. b) Critical Mach Number of fuselage.

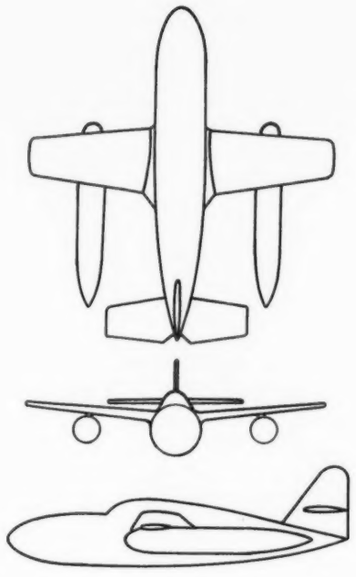


Fig. 21 : Messerschmitt Me 328
Root aerofoil : 0 00 12 – 1.1 – 30
Tip aerofoil : 0 00 12 – 1.1 – 30

assembled together. Fig. 19 presents the drag curves for the wing alone (a), the entire model without engine nacelles (c), and for the entire model with nacelles (d), plotted for an old model version of the Me 262, as shown in Fig. 26, and the critical Mach Number characterised by the definition $\frac{\partial c_w}{\partial M} = 0.02$. The line (b) indicates the critical Mach Number for the fuselage from Fig. 18, according to the definition $\frac{\partial c_{w\phi}}{\partial M} = 0.1$, and it is evident that the fuselage features the highest critical Mach Number. Whereas the wing (a) has an M_{kr} of about 0.73, the assembly of wing plus fuselage—the influence of the empennage would probably play a very small part only—results in a decrease of M_{kr} to 0.695. The nacelles, which are superior in the model than in the actual aeroplane, merely cause an increase in drag, but no change in the critical Mach Number. As we shall perceive more precisely, these critical Mach Numbers mostly do not correspond to the Mach Numbers which can be obtained in flight since—presupposing sufficient power reserve—the flight limit is established by the moment behaviour. The corresponding curves for the Ar 234, of which a G.A. drawing is shown in Fig. 23 (cf. [5] for photograph), are shown in Fig. 20 [6]. Owing to the relatively large nacelles, their assembly also causes a certain decrease in M_{kr}. The considerably lower critical Mach Number of the wing (a) of the Ar 234, as compared to the Me 262, is to be ascribed to the inferior aerofoil of the Ar 234 (cf. aerofoil data in Figs. 23 and 26). The absolute c_w-values relative to these two designs cannot be compared with each other very well, since both models were measured in different wind tunnels, the Me 262 in that of the Deutsche Versuchsanstalt für Luftfahrt (DVL) and the Ar 234 in that of the Luftfahrtforschungsanstalt Braunschweig (LFA).

Fig. 28 shows the c_w plotted against Mach Number for eight aeroplanes, the Messerschmitt Me 328, the Heinkel He 177, the Arado Ar 234, the Junkers Ju 287, the Heinkel He 219, the Messerschmitt Me 262 and Me 163, and the Dornier Do 335 [6, 7, 8], of which G.A. drawings are shown in Figs. 21 to 27 (see [1] for the Me 163), and some of which are shown in photos in [5]. The critical Mach Numbers are again characterised by the definition $\frac{\partial c_w}{\partial M} = 0.02$. The Me 228 and Ar 234 were measured in the LFA high-speed wind tunnel and the others in the DVL high-speed wind tunnel ; the models had spans of 1.2 to 1.5 metres. The drag coefficients are based on wing area including the nacelle portion. It is noticeable from Fig. 28 that certain of these types, the Do 335, for instance, feature a steep rise in drag, to which we are accustomed from aerofoil measurements, whereas others, like the Me 228, present a gradual increase in drag, which begins already at low Mach Numbers. The early and gradual drag increase is due to the fact that unfavourable forms of aeroplane parts, particularly of fuselages and nacelles, cause the airflow to reach sonic speed locally at low Mach Num-

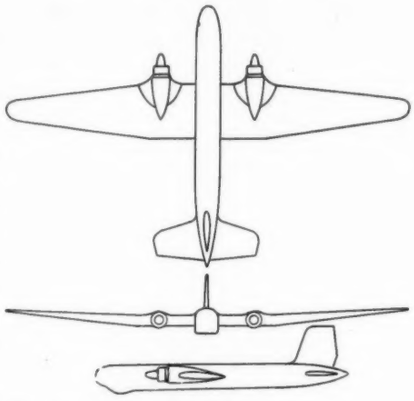


Fig. 22 : Heinkel $\begin{matrix}\uparrow\\\downarrow\end{matrix}$ He $\begin{matrix}\downarrow\\\uparrow\end{matrix}$ 177
Root aerofoil : 1.5 36.8 17.3 – 0.715 – 36.6
Tip aerofoil : 1.5 36.8 10 – 0.715 – 36.6

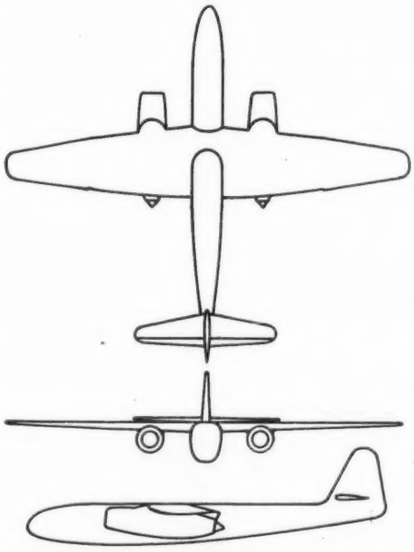


Fig. 23 : Arado Ar 234
Root aerofoil : 1.267 20 13 – 1.1 – 35
Tip aerofoil : 1.227 20 10 – 1.1 – 30

bers, thus provoking breakdown in flow. In cases where this breakdown area does not extend very far over the wing or empennage, the moment behaviour of the aeroplane is not disturbed in any great measure, so that flight at high Mach Numbers is possible providing there is a sufficient excess of power. Only when larger breakdown areas form on the wing, as a result of shock waves (which are usually faded out by the interference between fuselage, nacelle and wing at an early stage), do large shifts of the centre of pressure and, consequently, moment disturbances occur, which can finally no longer be balanced out by the elevators. Thus it may be stated that conventional aeroplanes have already attained their highest possible speed. The Mach Number corresponding to this limit speed shall be called $M_{kr\,.\,cM}$, so as to differentiate between the previous critical Mach Number for the drag increase, M_{kr}. The critical Mach Numbers M_{kr} resulting from the drag increase, according to Fig. 28, are plotted in Fig. 29 for the aeroplanes dealt with in Figs. 21 to 27. These values of M_{kr} are placed in opposition to the Mach Numbers $M_{kr\,.\,cM}$, which wind-tunnel measurements have shown to produce large changes in moment. It is evident that for aeroplane-type featuring high parasite and high interference drags, particularly the Me 328,

Fig. 24 : Junkers Ju 287
Root aerofoil : 0.9 23 12.7 – 0.825 – 40
Tip aerofoil : 0.9 23 10.7 – 0.825 – 40

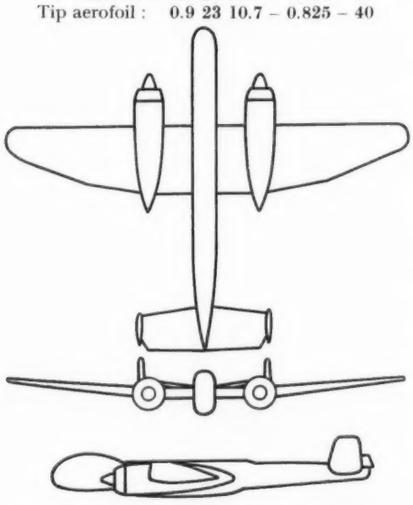


Fig. 25 : Heinkel He 219
Root aerofoil : 2 37 16.4 – 0.715 – 36.6
Tip aerofoil : 2 37 12 – 0.715 – 36.6

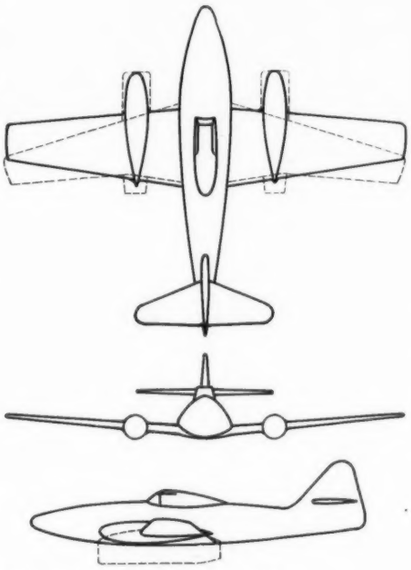


Fig. 26 : Messerschmitt Me 262
Root aerofoil : 0 00 12 – 0.625 – 40
Tip aerofoil : 0 00 12 – 0.625 – 40

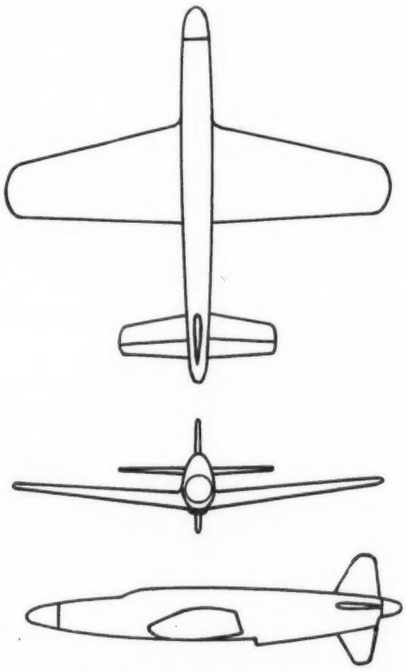


Fig. 27 : Dornier Do 335
Root aerofoil : 1.8 15 14.8 – 1.1 – 35
Tip aerofoil : 1.8 15 09 – 1.1 – 35

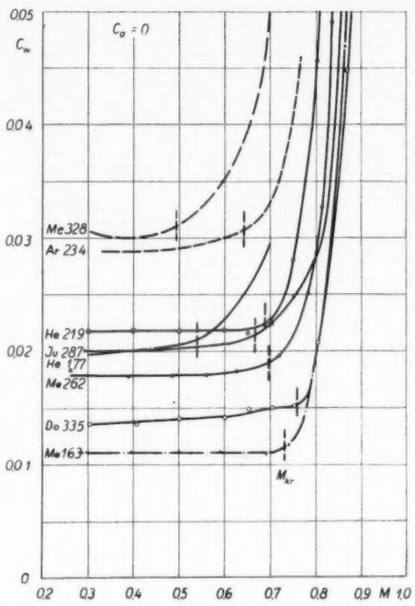


Fig. 28 : Drag versus Mach Number for aeroplanes featured in Figs. 21 to 27.

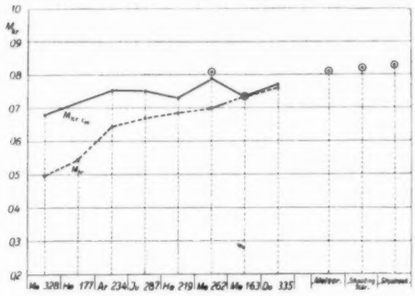


Fig. 29 : Drag increase M_{kr} and moment disturbance $M_{kr\,.\,cM}$ corresponding to critical Mach Numbers, for aforementioned aeroplanes. ◦ = Maximum speeds from flight measurements (Me 262 in slightly descending flight).

$M_{kr\,.\,cM}$ is considerably higher than M_{kr}, whereas aerodynamically-clean aeroplanes, for which the interference is relatively feeble (no badly-adapted engine nacelles), the two Mach Numbers lie very closely together. The Mach Numbers $M_{kr\,.\,cM}$ resulting from flight measurements [9] are plotted for the Me 163 and Me 262 ; and these coincide well with the wind-tunnel measurements. In order to round off the results, Fig. 29 also contains Mach Numbers representing about the highest flown hitherto —those of the Gloster " Meteor, " the Lockheed " Shooting Star, " and the Douglas " Skystreak. "

References

1. JUST and SAHLIGER : Aerodynamic Peculiarities of the Swept-Back Wing. " Interavia, Review of World Aviation " Vol. II, No. 9, P. 30-35.
2. NACA Technical Reports Nos. 460 and 492.
3. FELDMANN : Effets de la Compressibilité. " Interavia, Review of World Aviation " Vol. I, No. 1, P. 55-62.

4. GOETHERT : Messungen an Profilien im Hochgeschwindigkeitskanal der DVL. FB 1490.
5. L'héritage de la " Luftwaffe. " " Interavia, Review of World Aviation " Vol. I, No. 2, P. 25-29.
6. LIENARZ : Vergleich von Hochgeschwindigkeitsmessungen an einigen Flugzeugmodellen. UM 7823.
7. LINDEMANN : Vergleich von Ergebnissen an verschiedenen Flugzeugmodellen aus dem DVL-Hochgeschwindigkeitskanal. UM 1306.
8. LINDEMANN : Messungen am Modell der Ju 287. UM 1345.
9. KUHLE : Fluguntersuchungen über Eigenschaften um die Querachse bei hohen Machzahlen am Muster Me 262. UM 1418/1.

(FB = Forschungsberichte der deutschen Luftfahrtforschung ;
UM = Untersuchungen und Mitteilungen der deutschen Luftfahrtforschung.)

Symbols

v_0 = Airflow velocity
v_1 = Velocity on profile contour
a = Sonic speed
M = v_0/a = Mach Number of airflow velocity
M_a = Theoretical critical Mach Number = Mach Number at which sonic speed a is reached at any point on the aerofoil.
M_{kr} = Practical critical Mach Number at which the drag-increase really begins.
$M_{kr,cM}$ = Critical Mach Number for moment disturbance at which C.P.-shifts can no longer be balanced out with elevators.
p = Pressure
q = $\frac{\rho}{2} v_0^2$ = Dynamic pressure ; ρ = air density
α_∞ = Angle of incidence of aerofoil for aspect ratio $A = b^2/F = \infty$; b = Span, F = Wing area
t = Aerofoil chord
d = Maximum aerofoil thickness
δ = d/t = Relative aerofoil thickness
ξ_δ = Position of maximum thickness in percentage of chord t
f/t = Aerofoil camber
ξ_f = Position of camber-rise in percentage of chord t
ρ_{KZ} = Index for leading-edge radius
r = $\rho_{KZ} \cdot (\delta)^2 \cdot t$ = Leading-edge radius
r_n = Normal leading-edge radius ($\rho_{ZK} = 1.1$)
D = Fuselage diameter
L = Fuselage length
$F_\varnothing$ = Fuselage frontal area
c_a = Lift coefficient
$c_{w\varnothing}$ = Drag coefficient based on frontal area
ϕ = Angle of sweepback at $t/4$

Anti-Icing on Boeing's Heavy Aeroplanes

One of the most important features of a really all-weather aeroplane is the anti-icing system. Ice formation on the wing is particularly dangerous since it creates a double setback—causing loss of lift (up to half of maximum lift) and increased drag (up to 50 per cent. in cruising flight) : on the one hand by increasing the weight (up to 6 per cent.), on the other by impairing the aerofoil shape, i.e., by impeding lift development. Icing up to 15 per cent. chord-line, thus around the leading edge, is especially unwelcome, since it disturbs the air flow most in this area, and can also render the ailerons almost ineffective.

Then, ice on the empennage (displacing the C.G. and causing stability loss), on the airscrews (thrust loss and vibrations) and on the pilots' windshield (visibility) can turn out to be of critical consequence. Finally, the formation of ice in the air entries can seriously influence the running of the engines.

It is therefore not surprising that Boeing Aircraft Co., of Seattle, Wash., took infinite pains to devise reliable anti-icing systems for the two postwar descendants of the B-29 " Superfortress " : the Boeing 377 " Stratocruiser " (including the " Stratofreighter " cargo version and its C-97 military counterpart) double-decker grossing 130,000 lbs. and more, with a range of over 4,000 miles (Chicago-London) ; and the B-50 long-range bomber.[1] Both types have the same wing and empennage and both are powered by four Pratt & Whitney " Wasp Major " 28-cylinder four-row radials of 3,500-2,800 H.P., driving Curtiss electric reversible-pitch airscrews.

In contrast to previous systems, Boeing's idea was to prevent icing from the start, instead of fighting it after it had formed. Thus the inflated rubber de-icing boot, engineers' first answer to the ice problem, was rejected : aerodynamically unsatisfactory, it was not entirely effective and presented a maintenance and replacement problem, too. In its place, thermal anti-icing was proposed. This entails direct heating of all critical surfaces ; with special hot air (not from the exhaust) for wing and empennage, and electricity (instead of anti-icer fluid) for the cockpit windshield and the airscrews. Although worked out by Boeing specialists before the War, thermal anti-icing was not built into the B-17 and B-29 as it would have called for extensive re-tooling and, consequently, production delays. Meanwhile, the plan was " kept warm " by the National Advisory Committee for Aeronautics, which experimentally applied it to a B-17 at Moffett Field, California. As a result, Boeing engineers have been able to combine valuable NACA experience into the present system.

Hot air for the wing is provided by six Stewart-Warner " South Wind " combustion heaters, three installed in each of the outboard nacelles. Each heater has a capacity of 200,000 B.T.U., heat transfer being on the average 75 per cent. efficient, and normally burns 2.8 gallons of fuel an hour. Combustion and heating air is taken in through air scoops in the leading edge near the outboard nacelles and, under normal flight conditions, heated up to 300 deg. F. This is sufficient to maintain a differential of 100 deg. between the outside air temperature and the leading edges. Ground operation of the system is possible when the outboard engines are run at about 1,200 r.p.m.—to supply enough ram pressure at the scoops and enable the heaters to be operated at 200 deg. The object now is to transfer the heat as rapidly and efficiently as possible to the area where ice formation begins, where the highest rate of " water catch " occurs, thus to the impact edge of the wing ; and from there, downstream to the other points of the wing. How this is achieved is illustrated in Figs. 1 and 2.

Heated air is immediately distributed inside the D-shaped channel formed by the leading-edge skin and a vertical baffle plate, extending over the entire span. This channel is insulated by a fiberglas liner fitting the leading edge and insulating material facing the baffle plate, thus making a plenum or supply chamber along which the drop in temperature is held to a minimum. Between the leading edge and the fiberglas a corrugated duralumin inner skin is spot-welded

[1] Cf. " INTERAVIA, Review of World Aviation " Vol. I, No. 3, P. 21-26 and Vol. II, No.7, P. 24-25.

Fig. 2 : " D " duct in leading edge : note the fiberglas liner and the insulating face to the baffle plate.

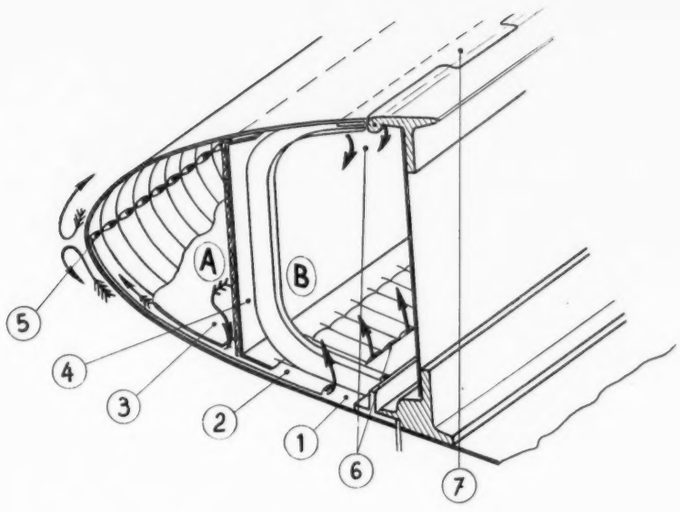


Fig. 1 : Typical leading-edge section.

1 : outer skin
2 : corrugated skin
3 : fiberglas liner
4 : baffle plate
5 : airflow intakes
6 : exit holes
7 : leading-edge hinge.

A : intake channel.
B : exit channel.

to the outer surface, thereby forming two systems of channels, one along the fiberglas liner (leading heated air to the ram point) and the other along the outer skin (leading heated air in chord direction away from the ram point). In the area of the leading edge —aft of the ram point of the profile—the corrugated skin is provided with openings (cf. Fig. 1). Hot air streams along the entire span of the leading edge, from the two end-edges of the " D " inside between the corrugated skin and the fiberglas liner to the foremost point of the " D, " and outside between the corrugated skin and the wing skin back again to behind the baffle plate, where it is collected for ejection through exhaust louvres located near the wing tips and nacelles. In this way it touches about eleven per cent. of the chord on the suction and pressure sides. Impact pressure alone is used for creating circulatory flow. Exhaust gases from the combustion heaters are dumped separately, so that they do not mix with the heated air. For maintenance, the leading edge is hinged to the front spar.

Anti-icing of tailplane and fin leading edges employs the same principle as the wing. Heated air is provided by two combustion heaters located inside the fin (cf. Fig. 3), combustion and heating air is taken in through a scoop in the fin's leading edge, and spent de-icing air is exhausted through louvres at the tip of each horizontal stabilizer and at the top of the fin.

In all, therefore, eight combustion heaters are provided ; together they consume about 23 gallons an hour, which is about four per cent. of engine cruise consumption. (Two more heaters of this type, placed inside the fuselage, provide warm air for cabin heating.)

Thermal anti-icing with clean heated air is doubtlessly superior to systems using exhaust gases, since it is not likely to provoke corrosion inside the leading edges. Meanwhile, it might be asked what measures are taken to counteract the considerable expansion arising from a temperature differential of 100 deg. between the outside air and the leading-edge interior.

The seven panels of the pilots' windshield are of NESA (standing for " non-electrostatic, " with the " a " added for euphony) glass, which comprises two outside layers of plate glass sandwiched to a middle layer of clear vinylite plastic, with a three-molecule-thick layer of transparent but electrically-conductive material on the inside surface of the outer pane. Current for heating this layer is provided by a special three-phase 11-KVA alternator, engine-driven. Thermistor elements regulate the flow of current and other such elements assure against overheating if the main controls fail. With the outside air temperature at —10 deg. and the aeroplane doing 300 m.p.h. at 5,000 ft., the NESA glass panels will maintain a temperature between 90 and 120 deg.

The Curtiss-Wright airscrews also have resistance heating elements to prevent ice. These run lengthwise in the blades, each two blades having a 28-volt d.c. supply and drawing 160 amperes. Since two blades alone need 4.5 KVA and there are sixteen blades to be heated, only two opposite blades of one airscrew are heated at a time. This is accomplished by a rotary timer with eight fixed contacts and a wiping contact, channelling current to two blades of each airscrew in turn ; then repeating, heating in turn the other two blades of each airscrew. For any given two blades, current is applied for 12 seconds in every 96 seconds. Airscrew de-icing is applied by the pilot when needed. Though temporary ice formation is not prevented, it is soon loosened and whipped off by the centrifugal force. (Similar thermal systems have been developed for Hamilton Standard airscrews, but with longer de-icing periods of 20 and 60 seconds.)

It may be mentioned, in conclusion, that the carburettors of the " Wasp Majors " are also well protected against the icing " bogy. "

Ri.

Fig. 3 : Test installation in the fin of two combustion heaters for anti-icing the empennage. Here, ram air is provided by blowers ; in flight, the impact pressure is used.

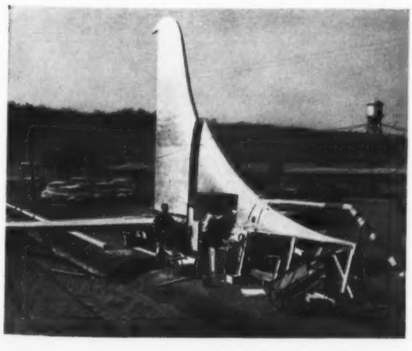


Fig. 4 : Electrically-heated and un-heated NESA panels in a refrigeration chamber.

Errors Evidenced by Direction-Finders

By Chief-Engineer Erkki Heino, Helsinki.

Just as in every measuring apparatus, certain errors are also evidenced by direction-finders. Depending on their nature, these errors are either so insignificant that it is not worth while taking them into consideration, or they are of such magnitude that they ought to be corrected in some suitable way before readings can be made use of. The following examination concerns only loop direction-finders working on long wave lengths, i.e., about 600-1,000 metres. Such equipment is widely used in sea and air traffic, especially in Europe.

The measurement errors can be divided into different groups, of which the most important ones are named in order: 1) the reading error proper; 2) the disparity between the calibrated loop and the measurement scale, caused by the tooth-gauge of the hand-wheel, the torsion, or other actuating devices; and 3) the errors caused by the deformation of the electric field.

The errors caused by the two aforesaid circumstances can, by improving the mechanical construction, be reduced to the order of one degree, and even less; but the errors caused by the deformation of the electromagnetic field are often so great that they have to be taken into consideration for each reading before the results can become useful.

When the loop direction-finders were first adapted to ships, aeroplanes and land stations, bearing errors were immediately in evidence. When the minimum audio strength was sought, the plane perpendicular to the loop did not place itself so that the transmitting antenna could reach it, but, when geographically examined, was found to have turned away several degrees to the right or to the left.

With regard to the time of day, it was very soon noticed that at the moment of sunrise and of sunset either the results were entirely faulty, or no audio minimum at all could be received. To eliminate such errors, which are understandably to the detriment of airline regularity, several expedients have been discovered.

As the D/F equipment on board ships is generally placed in the navigation room, thus in the plane of symmetry of the ship, the error curve assumes a fairly regular sine form (Fig. 1). This is caused by the masts and funnels being in the aforesaid plane. The readings contain an error which is generally below 10 deg., but may, under particular circumstances, even exceed this amount (Fig. 2). The error changes somewhat, depending on how deep the ship draws, i.e., on its cargo, but so little, however, that in practice it often cannot be observed.

The error curve can be determined in two different ways. In one method, which is generally used, notably in Finland, the ship is placed at a distance of some kilometres from the transmitting station, with the antenna mast distinctly visible. Then the ship is swung round on the spot, and the bearings and optical observations executed simultaneously. According to the other method, easy to apply anywhere, the ship remains stationary and a low-power transmitter is placed in another vessel; a tug, for instance. The second vessel turns round the ship continually, maintaining a constant radius whilst, as in the foregoing case, the corresponding bearings and optical measurements are taken. On the basis of these results the error curve can be plotted; and by means of this curve, bearings taken in bad weather can be corrected. Furthermore, even in clear weather, ships usually take bearings from radio-beacons and coastal stations in order to practice the use of the equipment, and also to be able to establish, by measurement, that the error curve tallies.

The measuring methods used for ships are also applicable to the adjustment of D/F equipment on aeroplanes. The most frequent practice is to place the aeroplane on a rotating stand which turns slowly whilst the measurements are being executed. When the D/F loop is placed in the aeroplane's plane of symmetry, with the loop being axially

Fig. 1: D/F error curve of a Finnish cargo vessel. Normal case.

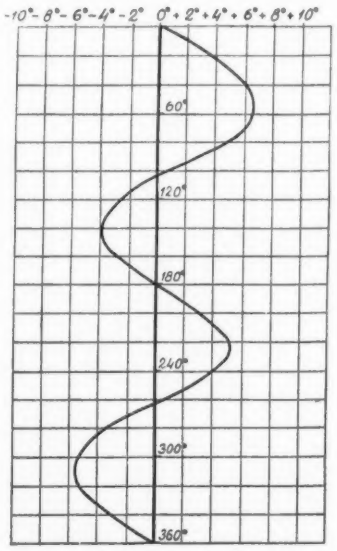
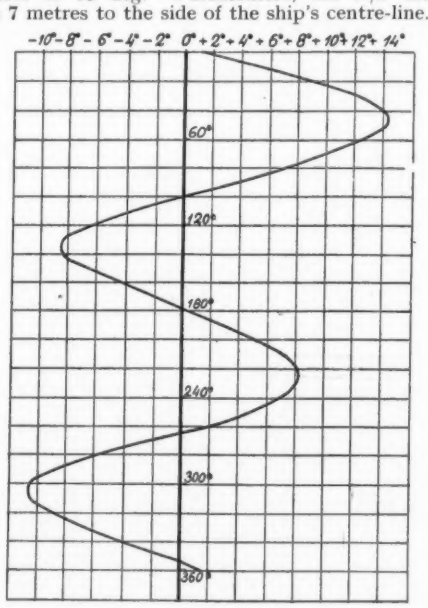


Fig. 2: D/F curve of another ship. The ventilation funnel some 2.5 metres away causes an error of 12 deg. Furthermore, the D/F set is 7 metres to the side of the ship's centre-line.



symmetrical, there results an error curve of the same type as that plotted on board ships.

In order to determine ship's bearings in relation to the mainland, D/F sets were at first installed at coastal stations. By having two or more coastal stations co-operate, the ship could take a fix, this being the point of intersection of the bearings taken from the different stations. Before the beginning of the second World War no electronic position-finding methods were used in civil aviation other than those incorporating loop-type antennae, but since the War, several new systems have been introduced. The general expansion of airline services has created a greater need for D/F equipment, so that all aerodromes ensuring airline safety are at present equipped correspondingly.

When the installation of D/F equipment at ground stations began, it was soon discovered that the form of the error curve was much more irregular than that common to ships and aeroplanes.

The form of the error curve was entirely dependent on local conditions. If the station could be situated in open terrain, with no metallic or electrical circuits in the vicinity, very near to ideal results could be achieved, since the errors were frequently of a few degrees only, and generally smaller than those common to seaborne installations. If, on the other hand, the local conditions were unfavourable, the results embodied accordingly high degrees of error. These different cases are revealed in figure 3. An example of the poorest results is given in curve 3, which shows among other things that for a certain receiving direction, the D/F apparatus gave two positive and one negative audio-strength minima; therefore, no useful bearings can be taken in the marked-off sector. This strange case was caused by two adjacent electric cables. When these were removed, the error curve changed for the better. Incidentally, practice has shown that if modifications have been made in a station's vicinity, the error curve ought to be revised before the equipment is used for traffic purposes.

If, contrariwise, the field intensity is measured in the immediate vicinity of a transmitter, it varies greatly, depending on the influence exercised by metallic masses in the neighbourhood. The field intensity decreases as the distance increases, but is equalised at the same time. At present, it is considered that the field is homogeneous at a distance of about 5 wave lengths from the transmitter.

For air navigation purposes, D/F station error measurements are generally carried out at a transmitting distance of 5 kilometres, with the wave length set at 900 metres. If aeroplanes choose to fly at an altitude of 500 metres, then they will maintain this altitude until they have arrived at the above distance from the aerodrome. The measurement is carried out with the aeroplane orbitting at an altitude of 500 metres and 5 kilometres distance from the D/F station being calibrated : twice with the sun and twice counter-clockwise, sending bearing signals all the time. At the D/F station, the results obtained by radio and optically are noted simultaneously. Measurement errors due to the relatively high speed of the aeroplane can be compensated in the final results by taking the average of the results read off for the same directional angles resulting from flights with the sun and counter-clockwise.

In practice, these error curves can be regarded as exact for fairly great distances and flying altitudes. For this reason, D/F equipment is used for directing aeroplanes to aerodrome vicinities from distances of several dozen kilometres. If the air routes are longer, one or more radio-beacons may be located at suitable distances apart. These radio-beacons can give aeroplanes their bearings and thus keep them on course. This system has been used in Europe, Finland included, for more than ten years and, in spite of numerous new inventions, is still preferred.

Quite different conditions can arise if the bearings are transmitted to an aeroplane flying at less than five kilometres away and at a lower altitude. If there happen to be any high-tension cables in the vicinity of the D/F station, then somewhat surprising results may be obtained. Investigation of a case like this yielded the results portrayed in Figure 4. The local conditions were as follows :

Distance of power mains from runway	1,650 m.
Distance of power mains from D/F station	1,330 m.
Width of path cut through wood transversely to power mains	38 m.
Width of path cut through wood in sloping direction	62 m.
Distance across power mains	15 m.
Direction of power mains	187 deg.
Height above sea-level north of runway	135.11 m.
Terrain slopes slightly after power mains.	
Height of power mains	15 m.
Power mains comprise	6

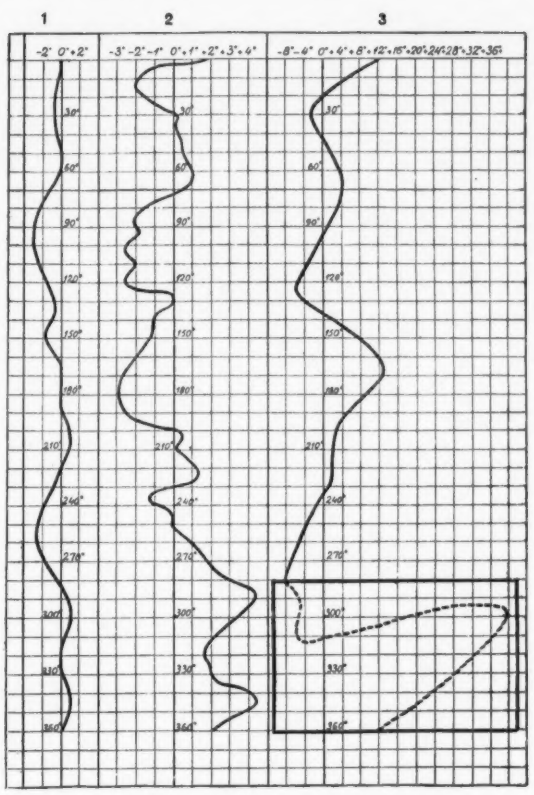


Fig. 3 : D/F error curves of three aeronautical stations : conditions in curve 1 are acceptable, less suitable in curve 2 and totally unsuitable in curve 3 ; bearings in the marked sector are unreliable.

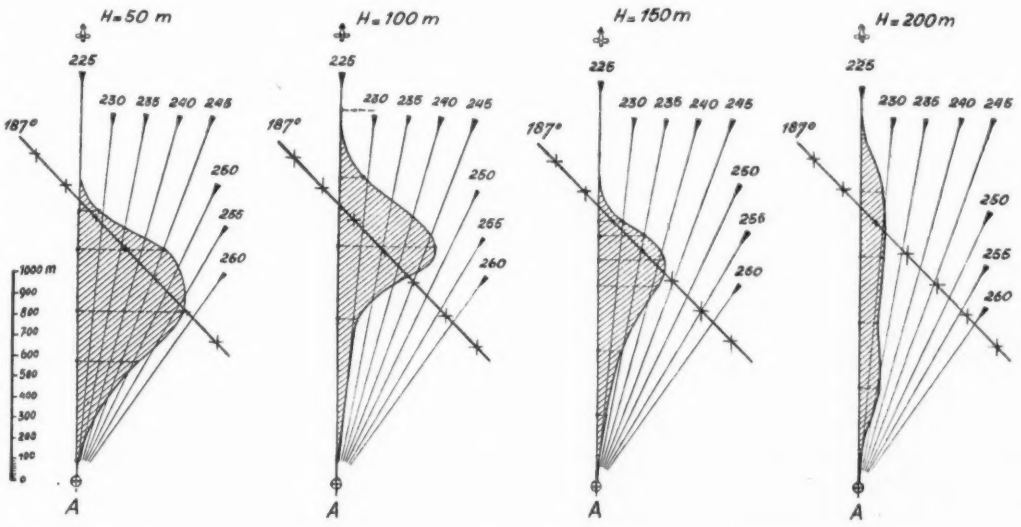


Fig. 4 : Bearing errors caused by power mains at different flying altitudes ; curve 1 determined at a flying altitude of 50 m, curve 2 at 100 m, curve 3 at 150 m, and curve 4 at 200 m. The thick line (187 deg.) represents the power mains, and the vertical line (225 deg.) the direction of flight towards D/F station A.

cables. Above these, two earthed lightning conductors 110 kV

Height of woods 12 to 18 m.

Unfortunately, for reasons of economy, it was not possible to conduct investigations into the cables' influence for other bearing directions ; of particular interest would have been the angle of 90 deg.

The measurements carried out show that the errors are very considerable for low flying altitudes. They are reduced rather quickly, however, as the altitude increases ; above 200 metres, they are not of abnormal magnitude, but remain under 5 deg. Meanwhile, since the above case occurred in the immediate neighbourhood of an aerodrome, the last-mentioned altitude is far too great for the circumstances.

From the above paragraphs it may therefore be concluded that if power mains run near to the aerodrome, no accurate bearing intelligence, useful for landing purposes, can be given to the aeroplane. Because it is also possible that other circumstances can affect the transmitter, i.e., influence the field intensity near to the aeroplane and deform the electro-magnetic field, it is clear that D/F equipment cannot be used at distances below five kilometres, and may not be utilised as a landing aid during bad weather. D/F equipment gives the best service in directing aeroplanes towards airfields, whereupon the landing approach proper should be executed with the help of a suitable instrument system. Such systems, already in use before the War, have since been improved considerably, and today form a part of the standard airline equipment.

Assessing the Efficacity of Aeroplane Armament

By O. P. Fuchs and Horst Kottas

I. *General Data*

The tactical duty of a fighter aeroplane is primarily to safeguard the air space. This can only be achieved by entering into combat with intruding enemy aeroplanes. Aside from the individual skill of the pilot, the ability to fulfil this duty is decisively influenced by the aeroplane's performance and the efficacity of its armament. The following example serves to show how very close is the relation between flight performance and efficacity of armament. Presupposing the pilot to be of average skill, we shall assume that, for a specifically-armed aeroplane, a combat duration of about five seconds is necessary in order to destroy an enemy intruder, in this instance a bomber, with a reasonable probability of success. Furthermore, we shall assume that the ballistic qualities of the aeroplane's guns (understood here in the widest sense, thus including the limits of application of the sighting device, etc.) are such that it would be pointless to open fire from a distance exceeding 1,000 metres (in longitudinal axis direction). Meanwhile, however, these data already limit the maximum combat speed which the fighter may use : there exists all the same a minimum distance at which the fire must be withheld (we shall suppose this to be 300 metres) since the fighter is obliged to bank away at this distance in order to avoid a collision and also because of the increased danger to himself. With this, there remains a combat distance of only 700 metres : for ballistic reasons, a period of five seconds is required for covering this distance. It is therefore to be deduced that the differential speed between the bomber and the fighter may only amount to 700/5, thus about 140 m/sec., which, assuming the bomber's speed to be about 100 m/sec. (360 km/h), leaves a maximum attacking speed of about 240 m/sec. (865 km/h) for the fighter.

Notwithstanding its simplicity, this example shows how closely flight performance and armament efficacity are inter-related. It is also meant to show that a limiting of qualities or performance, either relative to the aeroplane or to the armament, must not lastly, but rather firstly, be made on the basis of military considerations. Even the establishment of the average probability of success which should be realised in each attack, is coupled with statistical considerations of high strategic significance.

It may be said, very generally, that the rôle of the fighter aeroplane is merely to be a carrier, vested with certain qualities, of pilot and armament. Similarly, it might be maintained that combat aeroplanes should be built around armament that has been designed along military principles. In consequence, therefore, both armament development and aeroplane development are repeatedly being confronted by new problems : only in exceptional cases should it occur that the armament be designed to suit the aeroplane type, since it is the armament which constitutes the most important factor.

Disregardance of such considerations by the German military experts was not the least reason for the total collapse of the Luftwaffe fighter defences in the last phase of World War II. The original cause of the collapse was Hitler's decision in 1942 to stop work on the Me 262, when he declared that such a fast aeroplane was not necessary, later on to change his mind and order its operation as a high-speed bomber.

The last of the Luftwaffe's Chiefs of Fighter Requirements, Colonel Gordon M. Gollob, who was appointed *" General der Jagdflieger "* at the end of January, 1945, had long recognised that only an optimum armament-combination in conjunction with the Me 262 could endow the German fighter forces with the defence power which they had almost completely lacked up to that time. Whilst serving earlier appointments, Gollob had continuously sought to bring about a closer union between research and development, in order that the military viewpoints should be impressed upon the scientists and, vice versa, that the Luftwaffe should also bear the technical aspects in mind. For instance, it was due to his initiative that the development and manufacture of the small R4M rocket projectile was pushed forward after September, 1944. At that time no experience at all had been gained on the use of rocket projectiles as airborne weapons. Upon his appointment as Chief of Fighter Requirements, Gollob

worked out an armament-combination for the Me 262 (using the MG 213 C/30 machine gun and the R4M rocket projectile), tested it and at the beginning of February, 1945, published the instructions for its use in combat. As a consequence of his earlier efforts, sufficient machine guns and rocket projectiles of these types were available. On the other hand, there was a severe dearth of Me 262 fighters, because their manufacture had been severely impeded and the majority of existing units were being operated as high-speed bombers. And of the few Me 262 types available for fighter duties, not nearly all had been equipped with the EZ 42 sighting device (cf. Fig. 9), the only design suitable for the purpose; because at the time the Me 262's were fitted out the intention was not to use them as fighter aeroplanes. A quick acquisition of EZ 42 sighting equipment was altogether impossible at that time. The result was that, at the time he needed them most, Gollob possessed only about 60 aeroplanes that met his requirements and were at least partly-equipped with the armament he had specified. But not even this number of suitable aeroplanes met all the conditions : the RA 55 automatic firing device (cf. Fig. 8) for the R4M rocket projectile had not been produced, although the manufacturing centres concerned had had time and materials in sufficiency. Gollob was therefore compelled to have the rockets fired from small racks fastened to the wing, which, besides impairing flight performance, resulted in a disproportionately high ballistic spread.

Whereas during the July-August-September period of 1944 the ratio of the losses on both sides stood at 1 : 1 (i.e. for each German loss in combat, one Allied loss — for the most part fighters, with bombers in minority), the loss ratio for the period from February 22nd to March 26th, 1945, with Gollob's new armament combination in service (authentic data are only available for this period), amounted to about 1 : 7.5. For each German loss (fighter aeroplane) there were, therefore, seven-and-one-half Allied losses, the majority this time being constituted by four-engined bombers plus crews. These figures are significant.

Logically enough, of course, the major powers which took part in World War II adapted the development of their aeroplanes to that of the airborne armament, and vice versa. They were able to fall back on a plethora of experience, as for example the cine-gun records of attacks carried out, which were regulation in the R.A.F. and the U.S.A.A.F Naturally, the methods employed for these evaluations were kept secret. They called for a wealth of data gained from experience, a great deal of labour, and close collaboration between experienced staff officers and scientists.

The paragraphs which follow give a number of brief indications towards a simple method for assessing the efficacity of airborne armament. It is aimed solely to illustrate the basis on which such considerations repose ; thus to incite even the ordinary service pilot to assess the combat value of his aeroplane, including that of its armament, and to endow him with the means for following the developments in other countries in an objective manner.

II. *Destructive Power of Ammunition*

It is easy to understand that the combat efficacity of a gun is to a great extent dependent on the destructive power of the ammunition used. If one wishes, by any process, to obtain an efficacity rating for a weapon, then one must take into account the destructive power of the ammunition ; which, consequently, must first be defined numerically. As regards firing on airborne targets, one might very well ask how many hits, with a certain type of ammunition, suffice on the average to force an enemy aeroplane at least to land. This number of hits may be obtained for each type of ammunition at the expense of certain experimental difficulties. In the case of high-explosive ammunition, of course, the number is relatively easy to obtain. In this instance, it is sufficient to find out the necessary number of hits for two or at the most three calibres (or even for one calibre with varying explosive charge) in order to be able to determine the destructive power of high-explosive ammunition of all calibres; since it only depends here on the amount of explosive charge which each shell carries. (The firing performance figures given here were achieved with high-explosive ammunition under Gollob's instructions.) If the efficacity law is calculated from two absolutely-sure experimental data, such as are given here, no very great error will arise in the case of high-explosive ammunition of calibres within the limits under consideration—20 to 60 millimetres. These accurate results denote that 20 hits are necessary in the case of an explosive charge of 24.5 grammes per shell, and one hit when the shell is charged with 400 grammes, in order to force down an enemy aeroplane. These data are of course only valid for a specific type of explosive charge, in this instance, the type which was used for the tests under discussion. From these assumptions an equation can be formed which allows the number of hits necessary for " sure destruction " to be obtained as a function of the explosive charge.

As symbols we shall use :
m to denote the number of hits necessary for " sure destruction " ;
E for the explosive charge, in grammes per shell.
These symbols can be combined into a simple approximation formula :

$$m = \frac{496.4}{E} - 0.24 \qquad (1)$$

The high-explosive ammunition of 20-mm. calibre, as used for the MG 213 C machine gun (cf. Table 1, first line), is taken as example. The explosive charge was C = 24.5 grammes.

$$\text{Hence : } m = \frac{496.4}{24.5} - 0.24 = 20.26 - 0.24 = \text{approx. } 20$$

Accordingly, an average of 20 hits are necessary with this ammunition in order to destroy an enemy aeroplane (either a bomber or a fighter).

III. *Combat Efficacity of a Weapon*

With a certain amount of approximation, hardly avoidable in the calculation of complex " efficacity indices, " but coinciding fairly well with data obtained from numerous practical experiences, the " combat efficacity " (C_e) of a weapon can be worked out at :

$$C_e = \frac{n^2 \cdot t}{m \cdot \Sigma G} \qquad (2)$$

where :

- n denotes the rate of fire, i.e., the number of shots per second of which the weapon is capable ;
- t the maximum firing duration for continuous firing, limited by the amount of ammunition taken on board the aeroplane (measured in seconds) ;
- m the number of hits necessary for sure destruction, in accordance with equation (1) ;
- G the total weight of weapon, gun-mount and ammunition (for the firing duration of t seconds), including the weight of the ammunition belts (measured in kilogrammes).

The structure of this equation is easy to understand. The value $n \cdot t$ signifies the maximum number of shots with this weapon during the total combat duration t (fixed according to military statistics), for which ammunition is carried. Accordingly, the value $\frac{n-t}{m}$ denotes the number of enemies destroyed during a combat time of t seconds, provided all shots are hits. Since the time available for destroying this fictitious enemy is not without significance, the last mentioned value $\frac{n \cdot t}{m}$ is again multiplied by the rate of fire n. Finally, as the installation weight of the armament is likewise an important factor,

Fig. 1 : MG 151/20
Calibre : 20 mm
Rate of fire : 700 shots/min.
Muzzle velocity : 705 to 785 m/sec. Recoil loading with electric or mechanical detonation, electric remote control.

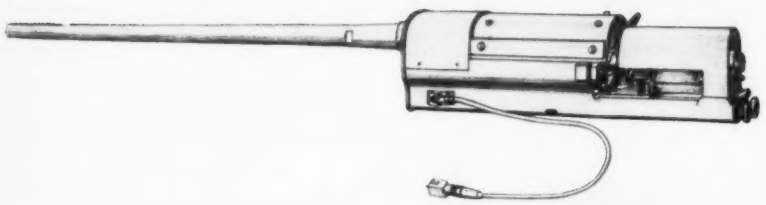


Fig. 2 : MG 213 C

Calibre :	30 mm	20 mm
Rate of fire :	1,150 shots/min.	1,200 shots/min.
Muzzle velocity :	550 m/sec.	1,000 m/sec.

Drum loading with recoil-piston actuator, electric detonation, pneumatic remote control.

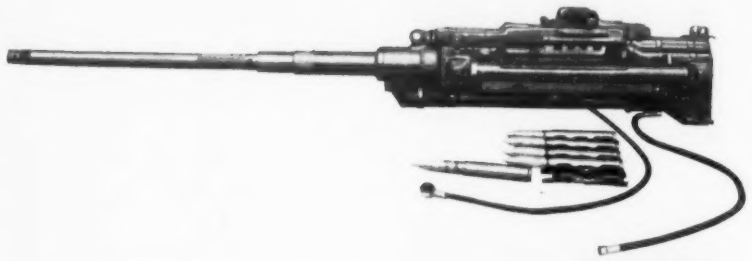


Fig. 3 : MK 103 (Aut. Cannon)
Calibre : 30 mm.
Rate of fire : 380 to 420 shots/min.
Muzzle velocity : 860 m/sec.
Recoil loading, electric detonation, electric-pneumatic remote control

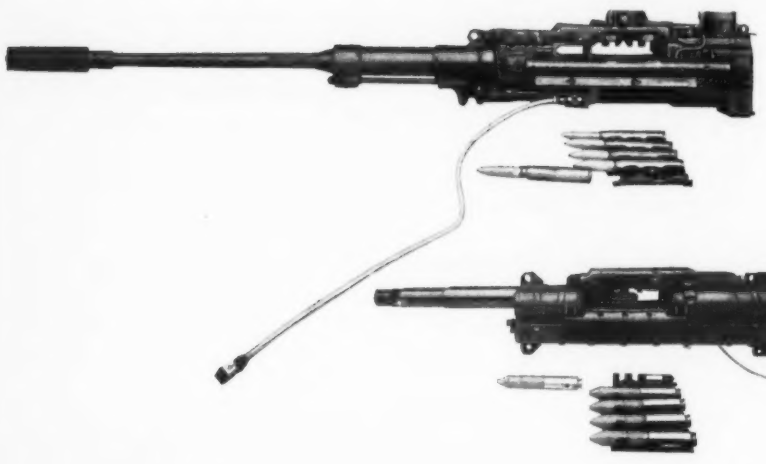


Fig. 4 : MK 103 (Nose Inst.)
Calibre : 30 mm.
Rate of fire : 380 to 420 shots/min.
Muzzle velocity : 860 m/sec.
Recoil loading, electric detonation, electric-pneumatic remote control.

Fig. 5 : MK 108
Calibre : 30 mm.
Rate of fire : 600 shots/min.
Muzzle velocity : 500 m/sec.
Mass-sealed recoil loading, electric detonation, electric-pneumatic remote control.

Fig. 6 : MK 214 A
Calibre : 50 mm.
Rate of fire : 150 shots/min.
Muzzle velocity : 920 m/sec.
Wedge-type breech with multiple loading, electric detonation, pneumatic remote control.

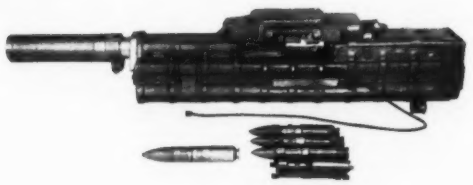


Fig. 7 : MK 112
Calibre : 55 mm.
Rate of fire : 300 shots/min.
Muzzle velocity : 600 m/sec.
Recoil loading with mass-breech, electric detonation, electric-pneumatic remote control.

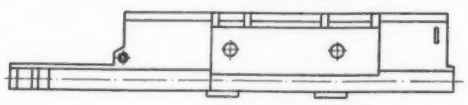


Fig. 8 : RA 55 (for firing R4M rocket projectiles)
Calibre : 55 mm.
Rate of fire : 300 rockets/min.
Rocket-missile automat without catch, electric detonation ; up to January 15th, 1945, no remote control had been provided.

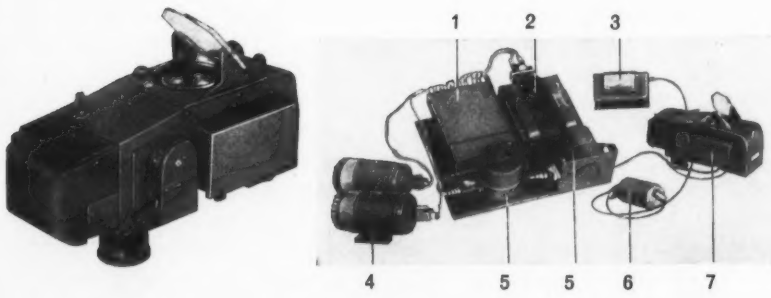


Fig. 9 : EZ 42 automatic reflector sighting device.
This device automatically gave the angle of deflection when used with airborne guns. It comprises a remote-controlled reflector-sight, 2 deflection-computers, an adjuster, a switch-box, an amplifier and 2 transformers : total weight, approx. 12.72 kgs.
1 Transformer
2 Switch-box
3 Amplifier
4 Adjuster
5 EZ 42/1 reflector-sight
5 Distance-measuring handle
6 Deflection-computer
7

Calibre mm	Type of Weapon	Weight of Weapon G_W kgs.	Weight of Gun-mount G_M kgs.	Total Weight $G_W + G_M$ kgs.	Weight of Ammunition [1] per shell G_a kgs.	Explosive Charge per shell C Grammes	Rate of fire n sec^{-1}	Muzzle Velocity v_o m sec^{-1}	Explosive used per sec. $C.n$ Grammes	Combat Efficacity C_e	Efficacity [2] Index C_{dev}	Hit/Shot ratio m	Recoil kgs.	Fig. No.
20	MG 151/20	44.5	(13.5)	58	0.25	18.5	11.66	Average 745	215.7	0.66	5.7	26.5		(1)
	MG 213C/20	75	(24)	99	0.39	24.5	20	1000	490	1.24	10	20	1,200	(2)
30	MG 213C/30	75	(24)	99	0.55	72	19.10	555	1,368	2.9	16	6.67		(2)
	MK 103/30 engine	133	(31)	164	1.00	72	Average 6.66	860	479.5	0.33	5.2	6.67	3,000 to 4,000	(3)
	MK 103/30 nose	140	(31)	171	1.00	72	Average 6.66	860	479.5	0.32	5	6.67	3,000 to 4,000	(4)
	MK 108/30	60	(22)	82	0.57	72	10	500	720	1.2	9.1	6.67		(5)
50	MK 214A/50	480	(30)	(510)	4.80	340	2.5	920	850	0.1	3.7	1.22	3,500	(6)
55	MK 112/55	270	(32)	302	2.85	420	5	600	2,100	0.67	10.6	0.94		(7)
	RA 55	23	(7)	(30)	4.00	500	5	520	2,500	1.47	115	0.753	very slight	(8)

[1] Bullets including belts.
[2] For 12-sec. firing duration.

Table I

this newest value $\frac{n^2 \cdot t}{m}$ is divided by the total weight G, whenceforth equation (2) results.

Now the efficacity indices computed according to equation (2) become greater when the efficacity increases and smaller when the efficacity decreases. Understandably, is not sufficient to evaluate the weapon alone. Equally important is the type of ammunition used, and the ammunition reserve. These efficacity indices will therefore differ for the same weapon, according to the type of ammunition used and to the prescribed firing duration ; which, however, is entirely in harmony with this study, because equation (2) ought to enable the most suitable weapon to be chosen for each set of prescribed conditions. The efficacity indices calculated therefrom may only be used in the sense given at the beginning of this article, since the formula utilised is not based on any profound physical principles. In this connection, therefore, it may be stated that only weapons that are in the same stage of development and within certain calibres may be compared with each other ; and these limits are, relative to muzzle velocity v_o, approximately 500 to 1,000 metres/second and, as regards calibre, about 20 to 60 millimetres. If these limits are respected, then the calculated efficacity indices will be found to coincide surprisingly well with the relative values gained from experience. *

The time value t, featured in equation (2), brings up the subject of statistics. The time t decides the amount of ammunition to be carried on board the aeroplane. It is fixed on the basis of a mathematical study, in which the fighting courage or individual skill is not taken into consideration. Its value can only be established on the basis of a great amount of experience as to the firing duration which may be realised, from the technical aspect, in each attack, aided by experience on the average number of attacks to be made per flight, and on the average ability of gunners ; and by accounting for the required average destructive effect for each flight, based on strategic considerations.

It may also be mentioned that in judging the weapon itself (its " developmental coefficient ") other viewpoints must also be borne in mind. In this connection, a coefficient of the following form (which we shall not expound further) has proved useful for summary assessments :

*** EDITORIAL COMMENT :**

One is inclined to ask whether a coefficient for the combat efficacity could not be derived from the fundamentals given by the authors, which would not only coincide with experienced values, like that defined in equation (2), but which would also suffice as regards stricter physical demands (e.g. for the dimensions) and the necessity for clarity. A few fundamental considerations are outlined in the paragraphs which follow.

The authors have very clearly and logically defined the value $\frac{n \cdot t}{m}$ as the number of opponents which can be destroyed within a combat duration of t seconds, provided all shots are hits ; this shall be expressed as z. This value must be multiplied by the hit/shot ratio ϵ (ratio between number of hits and number of shots fired) in order to obtain the number of opponents actually destroyed in each attack of ten seconds combat duration. This will vary from attack to attack. For reasons of simplicity, we shall assume that it contains all the factors relative to chance and circumstance. For a given attack, one could state :

$$\epsilon = \epsilon_{mean} \cdot \epsilon_1$$

where : ϵ_{mean} is the average of the values of ϵ for a large number of attacks (it should be emphasised from the start that this average does *not* correspond directly to the average number of opponents destroyed in each attack) ;

and ϵ_1 is an inherent value relative to the specific attack ; the average of ϵ_1 for a large number of attacks amounts to 1.

In order to clarify the relations, let us assume that it is possible to obtain the value of ϵ_1 for every 1,000 attacks, although this would be very difficult in practice. In this way we can plot a so-called distribution curve, with the value of ϵ_1 along the horizontal coordinate and the number of attacks during which ϵ_1 lies between two neighbouring values, on the vertical coordinate (Fig. 10). In accordance with the theory of probability, this distribution curve will assume a bell-shaped form, featuring a maximum at $\epsilon_1 = 1$. The width of the bell is dependent on a parameter which we shall disregard in the case of this fundamental consideration, by renouncing the abscissa scale of measurement. For an arbitrarily-wide range of ϵ_1-values, the number of attacks resulting in such values is proportional to the area enclosed by the horizontal coordinate axis, the two limiting vertical coordinates of the portion, and the bell-shaped curve. Of particular interest to us is the total amount of all attacks for which ϵ_1 exceeds the given value ; this number is plotted in Fig. 11, from which may be deduced that, independently of the width of the bell, 500 to 1,000 attacks will result in ϵ_1 being superior to 1.

Under which conditions of weapon efficacity and combat luck can one count on an opponent's sure destruction, or—said otherwise—what is the relation between ϵ_1 and the number of statistically-obtainable shots fired ? The temptation is simply to

$$C_{dev} = \frac{n \cdot v_o}{m \cdot G_W} + G_M \qquad (3)$$

where :

C_{dev} is an efficacity index for the developmental coefficient of a weapon with a specific type of ammunition ;

v_o the muzzle velocity for the specific type of ammunition (measured in m/sec.) ;

m as above, the number of hits necessary for destroying an enemy aeroplane ;

n as above, the rate of fire (shots per second) ;

G_W weight of the weapon without ammunition (measured in kgs.) ;

G_M weight of the gun-mount ready for installation (measured in kgs.).

IV. *Evaluation Results*

In order to give examples of the results which can be obtained with the above equations (1), (2) and (3), these three equations are applied to a series of nine German guns used in World War II. The bases of calculation, and likewise the results, are grouped comprehensively in tabular form. The results for the values m, C_e and C_{dev}, calculated according to our formulae, are contained the thickly-framed columns. The figures serving as basis for the calculation, bracketed in Table I, were not taken from authentic data, but estimated. The numbers in the last column refer to the illustrations.

V. *Resumé*

Three simple formulae have been given, with the help of which can be calculated the destructive power of high-explosive ammunition (Eq. 1), the combat efficacity of a weapon for airborne service (Eq. 2), and the developmental coefficient of a weapon with specific ammunition (Eq. 3). Despite their simple structure, these formulae enable values to be calculated, which coincide extremely well with those attained from experience, so that their utilisation may be recommended for many purposes. Their application to arms used by the Luftwaffe in the last war revealed, in the case of nine specific types, the superiority of the 30-mm MG 213 C machine gun and the RA 55 automatic rocket-firing device for the 55-mm R4M rocket projectile over all other types of aeroplane armament. The bases of calculation and the results therefrom are grouped in the table, and each illustration is accompanied by its relative data.

multiply z (number of opponents which can be destroyed per attack) by the average hit/shot ratio, ϵ_{mean}, and to regard the result as representing the average number of shots fired. Meanwhile, however, this would be a false conclusion : the value $z \cdot \epsilon_{mean}$, which is inferior to 1 in the majority of cases, only denotes in what measure, on the average, the enemy aeroplane is damaged in the course of its own attacks. We are much more interested in examining how many aeroplanes are completely destroyed during the course of 1,000 of our own attacks. If $z \cdot \epsilon_{mean}$ is inferior to 1, this will only occur in the individual attacks where ϵ_1 varies so much from the average value 1 that :

$$z \cdot \epsilon_{mean} \cdot \epsilon_1 \geqq 1$$

thus :

$$\epsilon_1 \geqq \frac{1}{z \cdot \epsilon_{mean}}$$

With this equation it is therefore possible to calculate the necessary minimum value of ϵ_1 for the sure destruction of an opponent. In this connection, it may be found out from Fig. 11 for how many of 1,000 attacks ϵ_1 assumes this or a superior value. Thus we can plot the curve shown in Fig. 12, which gives the number of opponents shot down per 1,000 attacks, independently of $z \cdot \epsilon_{mean}$.

An interesting theoretical limit case is where only minimum deviations from the average ratio of the number of hits to the number of shots occurs : $\epsilon \approx \epsilon_{mean}$ and $\epsilon_1 \approx 1$; the bell-shaped curve (Fig. 10) shrinks to a minimum width. The same applies to the aggregate curve (Fig. 11) : no attack with ϵ_1 considerably in excess of 1 ; 500 attacks with ϵ_1 only very little greater than 1 ; and 1,000 attacks with ϵ_1 superior to an arbitrary value inferior to 1. From the curve in Fig. 12 may be deduced : if $z \cdot \epsilon_{mean}$ is inferior to 1, not a single opponent can be destroyed with assurance ; if this value is exactly equal to 1, then 500 of 1,000 opponents will be destroyed (500 only just destroyed, but completely ; 500 nearly destroyed, but not quite) ; and if $z \cdot \epsilon_{mean}$ is superior to 1, then every attack will be a success. What does this signify ? The answer is a truism : if the question of chance could be eliminated, and all attacks were carried out under exactly the same conditions (also the same firing duration and spread), then a difference could only be made between weapons which are adequate for sure destruction of an opponent, and such that are inadequate. In this case, then, consequent improvement of the performance of an " adequate " weapon would, theoretically, entail no increase of the number of shots fired.

Contrary to the assumption made for equation (2), this comment has always referred to " attacks, " i.e., actions against a single enemy aeroplane with a correspondingly short duration of fire t. In practice, however, several attacks against different opponents should be carried out with certain weapons during each operation, for which purpose an increased firing duration with a correspondingly increased reserve of ammunition is provided. This case, in which the probability conditions for 2, 3 and more surely destroyed opponents would be liable to examination, cannot be investigated. In view of the unclear relation between the number of surely destroyed opponents and the firing duration t featured in the expression $z = \frac{n \cdot t}{m}$, it seems at least approximately right to calculate the number of shots fired per operation by adding up the number of shots for the separate attacks carried out during the operation, instead of introducing the total firing duration.

The following conclusions may be drawn from these considerations :

1. Successful attacks are equally influenced by :
   a) the rate of fire n ;
   b) the firing duration t per individual attack, fixed on tactical-technical grounds ;
   c) reciprocal value $1/m$ of the number m (dependent on the ammunition) of necessary hits for sure destruction of an opponent ; and
   d) the average ratio ϵ_{mean} of the number of hits to the number of shots fired.

   A theoretical reason for only raising the rate of fire n to the second power in a formula expressing combat efficacity, is not discernible.

2. The function according to which the number of surely destroyed opponents increases with the value of $z \cdot \epsilon_{mean}$, is discernible from Fig. 12, but cannot be represented with simple mathematical means since it varies according to which portion of the curve is under consideration.

The variable character of the curve underlines the particular importance of a profound statistical study such as that postulated by the authors, for only an examination of this kind can show which part of curve of opponents destroyed corresponds to the values of z obtained in reality, in which form z must be introduced into a formula that is approximate in theory and utilisable in practice, and what improvements of the combat efficacity can be achieved by means of a given increase of z.

T,

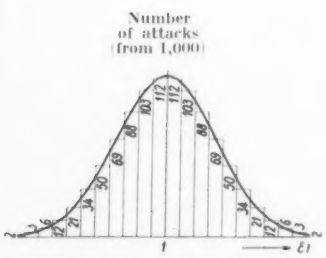


Fig. 10: Probable distribution of 1,000 attacks over different values of ϵ_1

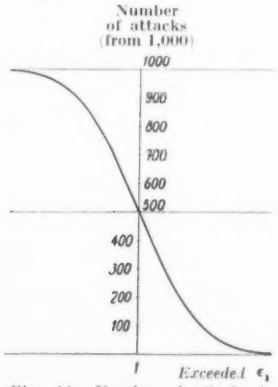


Fig. 11: Number of attacks in which a definite ϵ_1 (same scale as Fig. 10) will be exceeded

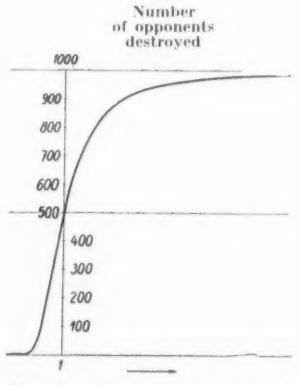


Fig. 12: Number of opponents destroyed in 1,000 attacks (attacks in which $\epsilon_1 \geqq \frac{1}{z \cdot \epsilon_{1mean}}$).

A Douglas DC-3 of C.P.A.L. at Dorval Airport, Montreal, Que. Dorval is one of the company's regional headquarters.

Airline to the Frozen North

BY HERMANN SCHOENEN, SEATTLE

Canada, with her vast area of 3,690,410 square miles and her relatively sparse population of just over 11,500,000 souls, probably relies on the aircraft as a means of transport more than any other country in the world. The reasons for this are twofold: first, rapid means of east-west communication are vital between the great industrial and business centres of the South, such as Quebec, Montreal, Ottawa, Toronto, Winnipeg and Vancouver, separated by hundreds and thousands of miles; second, air transportation in its various forms is the only practicable mode of locomotion to, from and in the great northern spaces with their mining and trading outposts, where roads and railways are almost non-existant and transportation is often limited to boats in summer and dog-sleds in winter.

The two categories of air transportation are the responsibility of two distinct types of major air carrier: the Government-owned Trans-Canada Air Lines flies the great trans-continental trunk routes, as well as to the United States and across the Atlantic; the privately-owned *Canadian Pacific Air Lines* operates the services to the frozen North of Canada and thereby represents one of the most important single factors in opening up this great area.

Growth of C.P.A.L.

Canadian Pacific Air Lines was organised in 1942. Long before that the Canadian Pacific Railway, parent organisation, had taken an active interest in aviation. In 1919, not long after the peace conference following World War I, C. P. R. obtained a special permit from the Canadian Government to own and operate aircraft commercially.

However, the company did not make use of this permit until 1933, when it became directly interested in commercial aviation by subscribing to a large block of stock of Canadian Airways, Ltd., which operated at that time in the western and northern areas of Canada. The company paid $250,000 for this transaction.

Meantime, Canadian bush pilots had begun flying more or less regularly into the little known sections of the great northern areas of Canada, pioneering the territories that eventually were to become the main routes of the Canadian Pacific Air Lines. The work of these early pilots was invaluable, but there were too many of them to achieve financially successful operations. Competition became destructive, with services and staff being duplicated and even triplicated. The lines themselves were in a chaotic condition. Rates were reduced to below operating costs, and the whole industry was headed toward bankruptcy.

At this juncture the Canadian Pacific Railway asked for and received the Government's approval to buy out some of the bush pilots. That was in 1939, and during the next two years the company acquired ownership of a number of the smaller lines.

The war in Europe caused a temporary change of plans. In July, 1940, the Government requested the C. P. R. to start an organisation to ferry bombers to the European battle grounds. The Government also specified that the company should carry all the essential Canada-England airmail. On November 10th, 1940, the first seven Lockheed "Hudsons" took off from Newfoundland and landed in Britain ten hours later. Soon it was decided to have C.P.R. ferry *all* planes that could fly the Atlantic. The ferry personnel was increased accordingly and included, besides the Canadian pilots, flying men of British Overseas Airways, of Britain's Air Transport Auxiliary, and pilots from the United States, South Africa, Australia, and South America. The administrative staff was selected from C.P.R's own ranks. Airport facilities in Newfoundland and at Bermuda were greatly enlarged. Eventually, test flights were made across the Pacific to Manila.

Later on, President Roosevelt asked that the ferrying operations be placed under military control. Accordingly, in July, 1941, the R.A.F. took over, and the ferrying contract was terminated. However, by that time C.P.R. had built up the ferrying operations to such efficiency that the bomber delivery system remained essentially the same during the entire length of the war.

Another major war effort of C.P.R. was its successful participation in the British Commonwealth Air Training Plan. The company inaugurated six air observer schools and operated them on a non-profit basis. A total of over 56,000,000 miles was flown during 1944 by the personnel and students of these schools. In addition, five engine-overhaul and aircraft repair plants were operated by C.P.R. for the servicing of Royal Canadian Air Force aircraft.

While this war-time activity halted the company's plans for organisation of its airlines, the experience gained during the operation of the ferry service gave the company invaluable "know-how" in carrying out its commercial project. When the ferrying service was concluded in 1941, work on plans for the airline network was resumed.

An aerial view of Dorval Airport, Montreal. This airport is one of the finest in Canada and of the entire North American Continent.

A Lockheed "Lodestar" flies along one C.P.A.L's routes over the snow-covered plains of Western Canada.

In all, ten smaller airlines systems were taken over and consolidated to form *Canadian Pacific Air Lines*. They were *Canadian Airways* (in which the company had previously acquired large ownership), with headquarters in Winnipeg ; *Yukon Southern Air Transport*, with headquarters at Vancouver and Edmonton ; *Quebec Airways*, with operations directed from Montreal ; *Dominion Skyways*, also operated from Montreal ; *Arrow Airways*, with main bases at The Pas, Manitoba ; *Prairie Airways*, operating out of Moose Jaw, Saskatchewan ; *Ginger Coote Airways*, of Vancouver ; *Wings, Ltd.*, with headquarters at Winnipeg ; *Starratt Airways*, operated from Hudson, Ontario ; and *Mackenzie Air Service*, with headquarters at Edmonton.

These air lines covered vast areas of Canada in the west, the north and the northeast. Some had been originated because of such developments as the discovery of oil at Fort Norman, Northwest Territories. Many prospectors were brought by plane in to the famous Yellowknife mining district on Great Slave Lake. And widely scattered fur-trading posts quickly recognised the value of the plane in getting supplies in, and getting furs out.

Varied as the reasons were for these airlines to come into existence, still more varied were the aircraft operated by them. They ranged from modern two-engine planes to small ski- and sea-planes which had seen their best days long ago. With these airlines, C.P.R. received a total of 77 aircraft of about 15 different types.

While this conglomeration of aircraft made maintenance rather complicated, it also made possible the two different kinds of operation that the newly formed company must carry on. It must maintain regular airline service over heavily-travelled inter-city routes ; and it must have bush line service to outlying points.

Successful operations and frustrated plans

Many difficulties had to be overcome in consolidating the various airlines into a smooth, efficiently working system, and there were times when it seemed as if all the problems had to be met at once. New schedules had to be drafted, equipment transferred to points where it was best suited to existing conditions. New airfields with the necessary hangars and other facilities had to be built, and existing facilities enlarged and modernised. New repair shops had to be constructed, radio control systems installed, new personnel trained.

In spite of these problems, the airline carried 70,000 passengers, 2,200,000 lbs. of mail and 9,100,000 lbs. of cargo in 1943, the first full year of consolidated operations ; the passenger and mail figures represented a very substantial increase over the loads carried during the previous year on the same routes. Soon it was found necessary to obtain additional aircraft —twin-engined Lockheed "Lodestars" and Boeing 247's, the only types available in wartime—and again to enlarge ground facilities. In addition, operating, maintenance and traffic policies had to be brought up to the standard of a mainline.

A bush-line airport on C.P.A.L's route network : the airstrip at Yellowknife, Northwest Territories, centre of an important mining area.

Encouraged by its success, Canadian Pacific Air Lines began to look farther afield. Very early in 1944, the company announced that it was preparing a regular air service across the North Atlantic to various points in Europe ; it also elaborated a post-war aircraft procurement programme comprising trans-oceanic, trans-continental, feeder-line and utility aircraft, as well as helicopters. Later in the year, however, the blow fell : the Canadian Government, which for some time had been watching C.P.A's efforts with considerable misgivings, came out in the open and declared that its "chosen instrument," the State-owned Trans-Canada Air Lines, would be solely responsible for Canada's international services and domestic trunk services, that the railways (meaning Canadian Pacific Railways) would be required to divest themselves of the ownerhsip of their airline interests (meaning Canadian Pacific Air Lines). It was understood at the time, furthermore, that the Canadian Government would ask C.P.R. to return the ten lines it had acquired in 1942 to their former independent status, thus eliminating any serious danger of competition by any major concern to its own T.C.A.

The Government's post-war air policy was scheduled to be enforced within one year after the close of hostilities, i.e., by Spring, 1946, and would have relegated C.P.A.L. to the role of a feeder operator. However, in March, 1946, the Dominion Government announced its decision to permit the C.P.R. to operate airline subsidiaries (C.P.A.L.) for "at least another year." No special order was passed ; the Cabinet simply decided not to implement its previously stated policy. A few months later, in August, 1946, the Rt.Hon. Clarence D. Howe, Minister of Reconstruction, announced a complete reversal of this policy when he declared in the House of Commons that he now "favoured continuation of railway-airline affiliations."

Up to the present time, no order-in-council has yet been issued implementing the Minister's about-face. The general feeling is, however, that the matter of separation of railway and airline interests is now a dead issue ; that it is a political "hot potato" that will not be revived by the present Government. It now seems to lurk in the corridors of Parliament only as a measure some socialist-minded administration of the future might revive as a preliminary divestment of power of Big Business—of which the Canadian Pacific Railway Company is the Dominion's greatest example.

Nevertheless, the company had to sacrifice its major project involving the operation of Canadian overseas trunk routes. Undismayed, C.P.A.L. concentrated on its long north-south services, its feeder-line operations and its varied bush-flying and charter activities, in which C.P.R. invested $7,000,000 by the end of 1945. But even on its more modest basis, the company has made progress year by year. For instance, during 1946 it carried 16,514,741 lbs. of cargo, as compared with 9,419,556 lbs. in 1945 ; 1,722,733 lbs. of air mail against 1,253,537 lbs. in 1945 ; and 175,461 revenue passengers against 125,110 in 1945. It flew 6,813,907 miles in revenue service compared with 5,373,403 miles in the previous year. During 1946, operations showed a net profit of $372,371 compared with a loss of over $300,000 in the previous year. The operating ratio

A C.P.A.L. Douglas DC-3 getting ready to leave Dorval Airport, Montreal. DC-3's are used for the company's mainline traffic.

for 1946 was 95.3 per cent. as against 107.3 per cent. in 1945.

In the spring of 1947 the company had a fleet of 59 aircraft, operating over 5,370 miles of licensed routes. Among these aircraft were four converted Consolidated PBY-5A twin-engined amphibians and 16 Douglas DC-3's, 15 of which were equipped to carry 28 passengers. There were also 9 Ansons and 5 Hudsons which were used entirely for aerial surveys.

The accompanying map shows that while the operations of the C.P.A. cover the entire Dominion, some of the most important services are flown in the western and northern parts of Canada—mining and fur-trading areas of the Yukon and the Mackenzie districts. In all the districts, but especially in the East, charter flights frequently supplement the regular scheduled flights. These flights carry supplies to the agents of the Indian Affairs Department, and to the staffs of the Land and Forests Division, Mines and Resources Divisions, and others. C.P.A.L. planes have helped the Transport Department to establish meteorological and radio stations at isolated locations in the far north. Many mercy flights are made to bring doctors to otherwise inaccessible outposts and to supply ambulance service for transporting the sick or injured to hospitals.

Offices at Winnipeg have general operational and traffic supervision of the entire system, with regional headquarters at Vancouver, Edmonton, and Montreal.

C.P.A.L. pilots in the company's staff house at Whitehorse in the Yukon.

Traffic representatives who have been assigned to each district keep in constant touch with the various localities within their territories. Passenger offices are maintained for the convenience of air travellers in many Canadian cities and through the railway offices in New York, Detroit and San Francisco in the United States. Stewardesses are provided on all mainline runs out of Vancouver, Edmonton, Regina, Winnipeg and Montreal.

Maintenance problems

Since C.P.A.L. operates mainly north-south routes over varied terrain and in varied climates, using many types of planes, its maintenance problems are considerable.

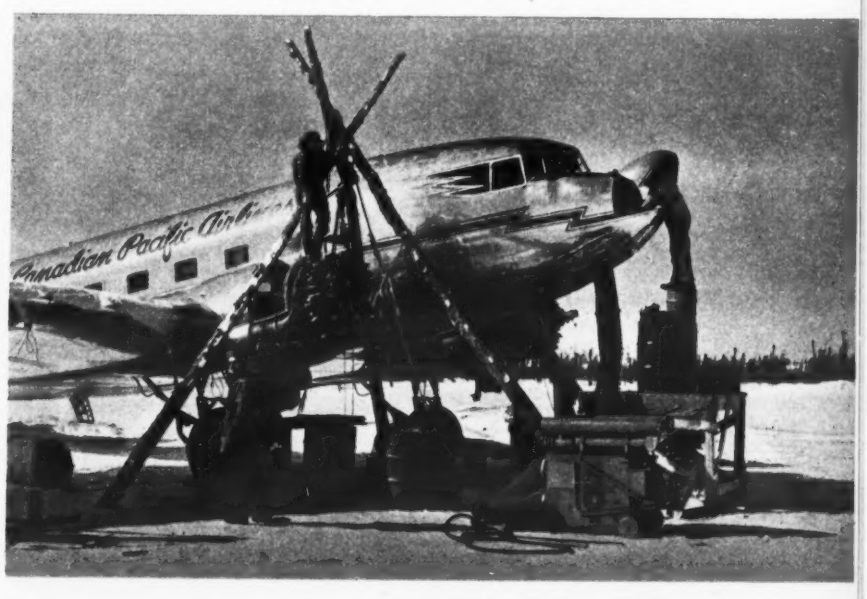
The maintenance and overhaul routine depends to a great extent on the facilities available, particularly during the winter months. That many planes use floats in summer and skis in winter does not simplify matters. Therefore, it is evident that C.P.A.L.'s maintenance problems differ from those usually facing the commercial transport operator.

Canadian Pacific Air Lines has developed two systems of regular inspection. All overhaul and inspection work is done under the supervision of the general superintendent of maintenance, with headquarters at Winnipeg. He is assisted by the chief maintenance engineer, and regional superintendents of maintenance who keep in constant touch with the various maintenance points by frequent personal visits.

Whilst mainline maintenance roughly follows the practices in use by any regular airline, the matter of

Old and new forms of transportation meet : the Royal Mail is transferred from airplane to dog team at a landing field in Canada's far North.

Servicing a transport poses many problems at the mainline airports of Northern Canada.



bush line maintenance is quite another thing. Each aircraft in bush line service carries a "complaint book" in which is listed all work that has to be done. Five different kinds of inspections are made.

The first type is a routine inspection, made daily before each flight. The second type of check is made after 25 to 30 hours of flying. This inspection consists of all daily checks plus the removal of all engine cowlings, inspection of engine installation, exhaust manifolds, and so forth. A thorough inspection is made of the entire frame, wings, empennage, and emergency exits. Check number three takes place after the aircraft has flown 50 to 60 hours. In addition to all work done in connection with checks number one and two, this inspection includes changing spark plugs, flushing the carburettor, checking induction manifolds for tightness, and checking all primer lines and connections. After an aircraft has flown between 180 and 200 hours, it is due for check number four. This consists of all previous work. In addition, a thorough check is made of valve springs, rocker arms, and magnetos. All cylinder base nuts are checked for tightness. The oil sump is drained, all electric wiring is tested, the engine booster magneto is tested, and all engine controls are inspected. The propellers are removed and inspected, and the entire engine installation is thoroughly cleaned. Special attention is paid at this time to fairings, cabin heaters, tabs, flaps, and stabilisers. The whole plane receives a thorough and detailed going-over with check number five, made after 1,000 to 5,000 miles, depending on the type of aircraft.

To comply with these requirements, particularly during the winter months which can be extremely severe in some of these regions, is not by any means an easy task. Only a few bases out of which the bush

Engine overhaul in C. P. A. L's hangar at Whitehorse, Yukon.

line planes operate have hangars which are suitable for more detailed inspection and maintenance work. During the winter months most of these bases have only nose hangars for these jobs. Hangars for complete overhauls are located at Winnipeg, and for periodic checks at Edmonton, Vancouver and Mont Joli. All major repair and overhaul work on aircraft is being centralised at Stevenson Field, Winnipeg, bringing about increased economies and at the same time assuring the same high standard of work for all planes on all lines.

"Maid-of-all work" operations

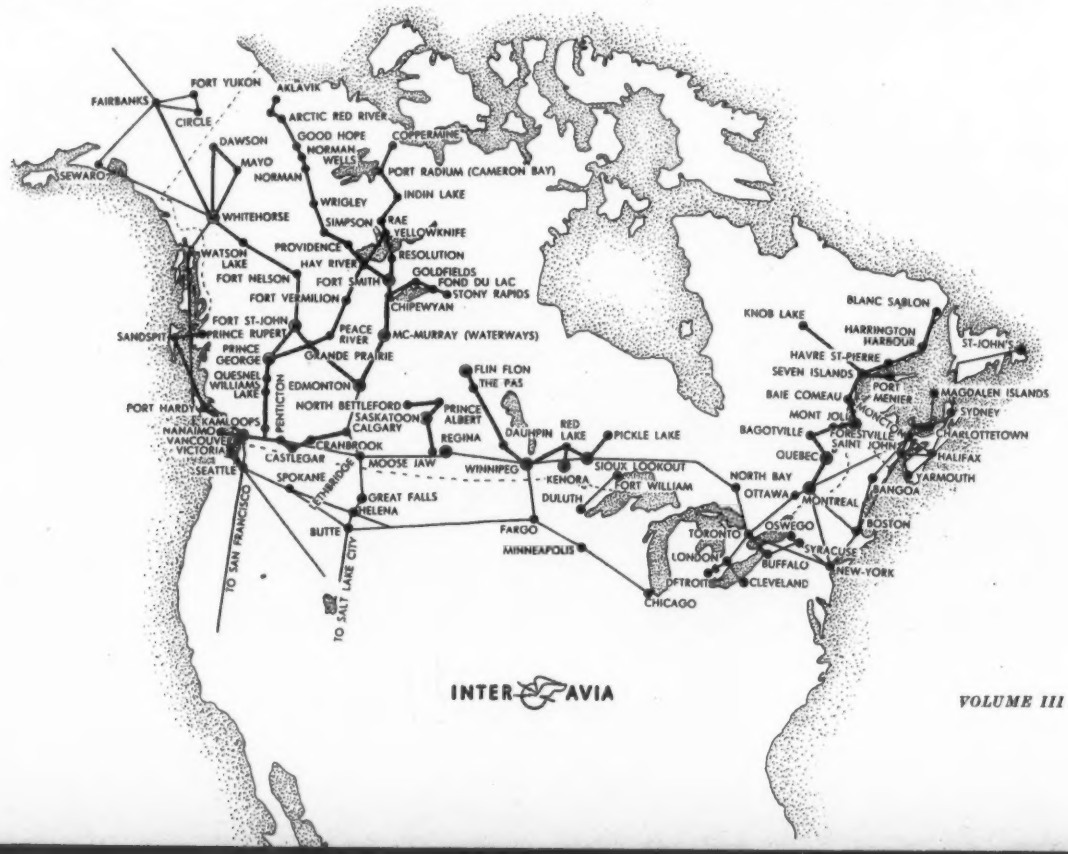
While the cargo carried on the main line planes is similar to that of most standard commercial airlines, shipments made by bush line planes comprise a multitude of things. Besides passengers and mail, these planes on their regular scheduled runs carry explosives for mining operations, drilling equipment, engines for mining camps, furniture for settlements that are inaccessible by any other means of transportation, fresh food, live stock, in fact anything and everything needed to make this vast northland habitable for human beings. In addition to these things, C.P.A.L. planes always carry emergency supplies, in case of the remote possibility of being stranded far from a base. The ration tin contains a large assortment of canned dehydrated food, and there is other equipment such as a frying pan, a roll of copper snare wire, mosquito nets, fish trolls and nets, a gun, and an axe.

If no airfields are available, or if the snow is too deep to make landing safe, winter mail is delivered by means of the so-called "bombing run," in which the mail sacks are tossed out through a chute in the plane near a flag staked in the snow by the postmaster. Outgoing mail is transported by dog team to the nearest "airport"—which usually consists of a small clearing in the bush or just a frozen lake, with a runway perhaps tramped out by the inhabitants on snowshoes.

There is plenty of reason to believe that the future will bring the C.P.A.L. prosperous and expanding traffic. The feeder lines are credited with serving four-fifths of the Canadian territory, with little fear of competition from ground transportation. Dwellers of these great areas—trappers, miners, and prospectors have learned to depend on planes for their supplies throughout the year. Furthermore, there are still some areas—especially between the cities of Quebec and Winnipeg, and between Winnipeg and Regina—that have not yet been touched by the feeder lines. Here is more room for expansion.

REGULAR AIR SERVICES OPERATED BY C.P.A.L.:

Montreal—Quebec—Saguenay—Forestville—Baie Comeau—Mont Joli.
Baie Comeau—Seven Islands.
Seven Islands—Knob Lake.
Winnipeg—Red Lake—Kenora.
Edmonton—Grand Prairie—Fort St. John—Whitehorse—Fairbanks.
Whitehorse—Mayo—Dawson City.
Edmonton—McMurray—Fort Smith—Fort Simpson—Norman Wells.
Edmonton—McMurray—Fort Smith—Yellowknife.
Norman Wells—Aklavik.
Edmonton—Grand Prairie—Peace River—Fort Vermilion—Hay River—Yellowknife.
Yellowknife—Port Radium.
Vancouver—Prince George—Fort St. John.
Vancouver—Nanaimo.
Vancouver—Port Hardy—Sandspit—Prince Rubert.
Regina—Moose Jaw—Saskatoon—Prince Albert—North Battleford.
Winnipeg—Dauphin—The Pas—Flin Flon.
Sioux Lookout—Red Lake.
Sioux Lookout—Pickle Lake.



Northrop YB-49

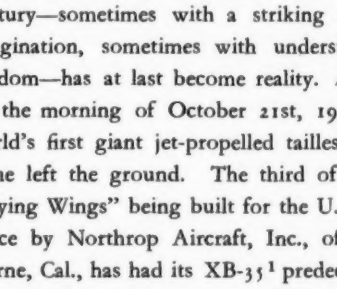
The aeroplane of the future which countless artists have repeatedly endeavoured to portray during the past quarter of a century—sometimes with a striking lack of imagination, sometimes with understanding wisdom—has at last become reality. At 9.46 on the morning of October 21st, 1947, the world's first giant jet-propelled tailless aeroplane left the ground. The third of fifteen "Flying Wings" being built for the U. S. Air Force by Northrop Aircraft, Inc., of Hawthorne, Cal., has had its XB-35[1] predecessor's piston-engines and airscrews replaced by eight General Electric J-35 jet engines with a combined potential output equal to 32,000 H. P.

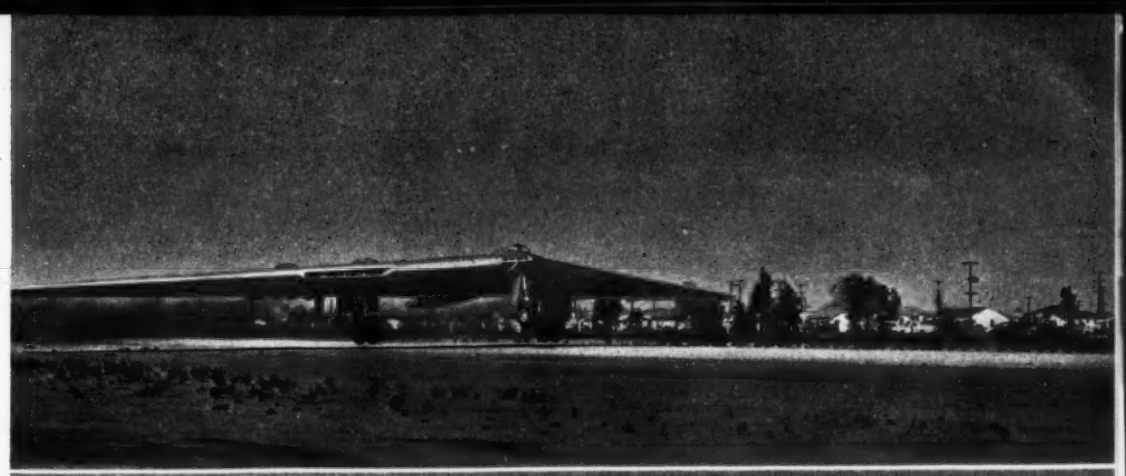
Like the XB-35, the YB-49 jet version features a wing span of 172 feet, but its gross weight has been stepped up from 162,000 lbs. to 200,000 lbs. The four jet engines on either side are, of course, wholly housed within the wing ; packed closely together, their rectangular air entries form a single slot in the leading edge. Meanwhile, the cylindrical jet nozzles project separately beyond the trailing edge. To the right and to the left of each group of nozzles is a vertical fin, preventing the gas ejection from being disturbed by cross-flowing air streams.

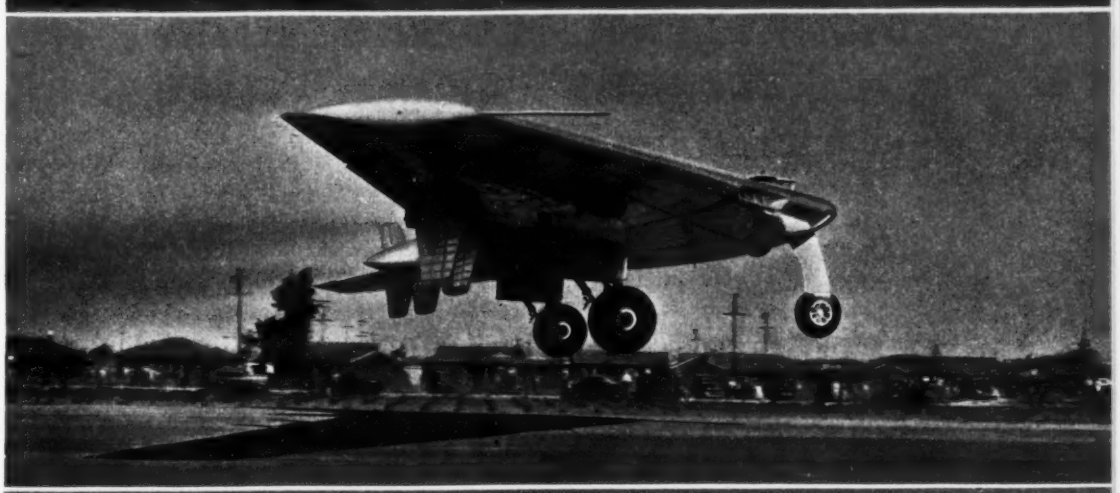
The new aeroplane's performance surprised even its designers. When the pre-calculated take-off speed was reached and Northrop test pilot Max Stanley wanted to take off gently, the "Flying Wing" fairly leaped into the air : this is evidenced by the position of the nose-wheel in the upper photograph.

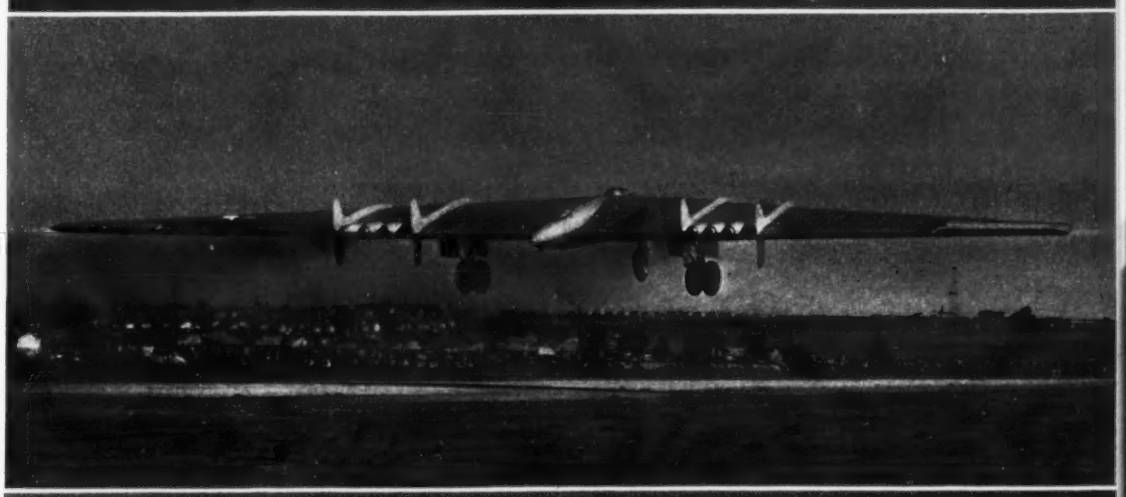
Thirty-four minutes later, the YB-49 had crossed the San Bernardino mountains and landed at the Muroc Air Base in the Mojave desert, where, away from prying eyes, it is undergoing a series of extensive flight tests.

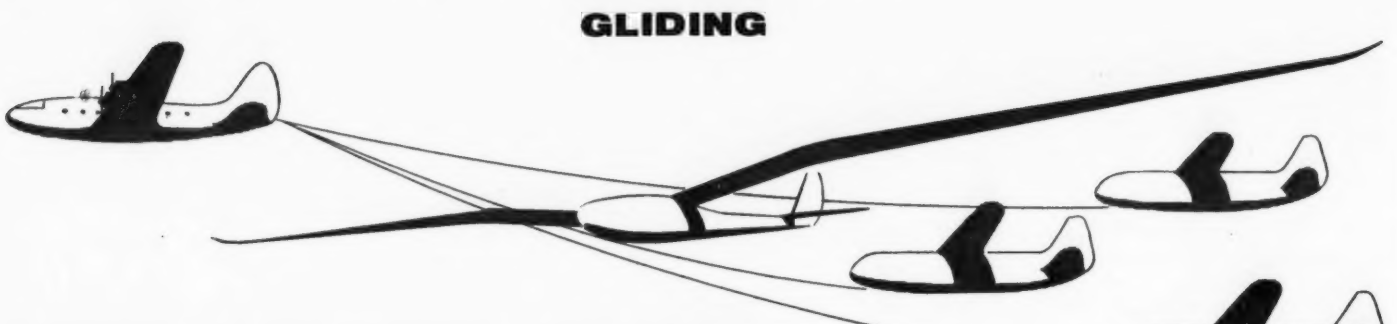
[1] Cf. "INTERAVIA, Review of World Aviation" No. 2, May, 1946, P. 18-22, and No. 4, April, 1947, P. 26-31.











FROM TAILLESS GLIDER TO JET AEROPLANE

BY SQUADRON LEADER ROBERT KRONFELD, LONDON

On November 13th the Armstrong-Whitworth A.W. 52, a twin-jet tailless research aeroplane (Fig. 1), made its first flight at the Royal Air Force Experimental Establishment, Boscombe Down. The firm's young and energetic test pilot, Squadron Leader E.G. Franklin, was sufficiently satisfied with the handling characteristics of the new aeroplane to remain airborne for 25 minutes, a fact which was recorded with satisfaction by the Chief Designer, Mr. T. Lloyd, and his staff (Fig. 2). If it had not been for a delay of several months owing to trouble with a part of the control system which should have been irreversible but wasn't, the A.W. 52 would have taken the air before the first successful flight of the YB-49, the jet version of the Northrop B-35.

This new experimental jet aircraft of 90-feet span and 32,700-lbs. all-up weight is of very advanced design, and quite a few design eggs were put into one basket. That none of them were broken on the first flight is to a great extent due to the fact that large design risks had been reduced to a minimum by developing this aircraft "the glider way" (Fig. 3). It is a noteworthy fact that nearly all designers of successful tailless aeroplanes have experimented with piloted scale gliders before building the full-size powered version. They all appreciated the extra design risk introduced by problems of control and stability of the tailless type, and the consequent desire was to have something for initial research approaching the aerodynamics of the full-size version more closely than the wind-tunnel model. Sir W. G. Armstrong Whitworth Aircraft, Ltd., and General Aircraft, Ltd., both working for the Directorate of Scientific Research, had adopted this policy in

Fig. 2: *Mr. T. O. M. Sopwith*, Chairman of Hawker-Siddeley Aircraft Co., Ltd.; *S/Ldr. E. G. Franklin*, Test Pilot, and *Mr. T. Lloyd*, Chief Designer, of Sir W. G. Armstrong Whitworth Aircraft, Ltd.; *Sir Ben Lockspeiser*, Director-General of Scientific Research (Air), Ministry of Supply.

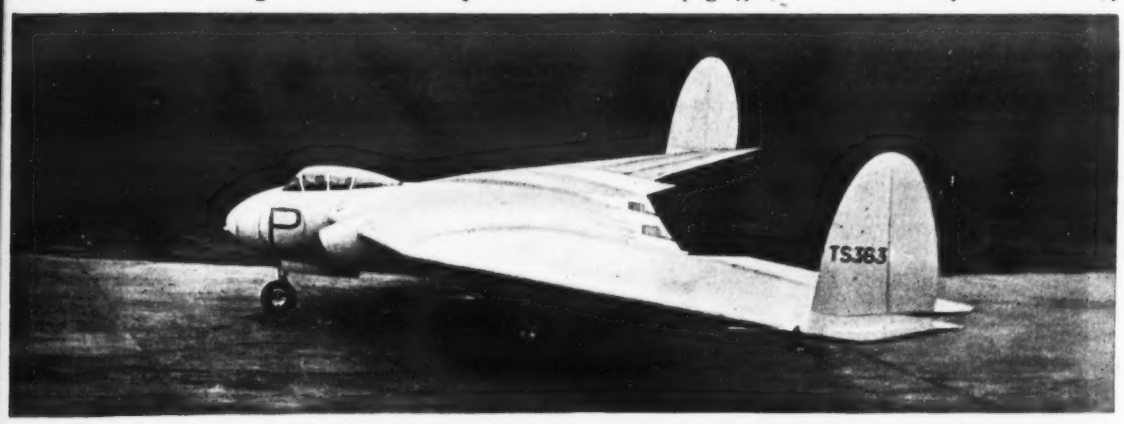
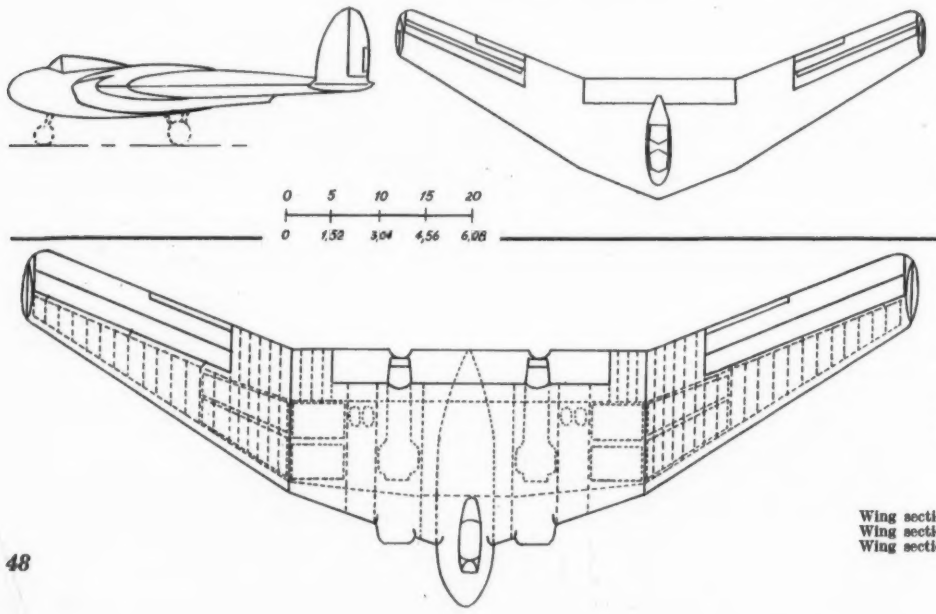


Fig. 1: Armstrong-Whitworth A.W. 52 tailless aeroplane prior to its first flight at Boscombe Down. Power plant comprises two Rolls-Royce "Nene" jet engines.

Fig. 3: Comparison of the glider and twin-jet versions of the A. W. 52.



A.W. 52 GLIDER	
All-up weight	6,000 lbs.
Gross wing area	445 sq. ft.
Wing span	53 ft. 4 in.
Wing loading	13.5 lb./sq. ft.
Wing aspect ratio	6.4
Angle of sweepback (on 1/4 chordline)	25 2/3 deg.
Controller area (each)	20.5 sq. ft.
Corrector area (each)	18.8 sq. ft.
Total area of fins and rudders	33.4 sq. ft.
Flap area	57.3 sq. ft.

A.W. 52 TWIN-JET	
Take-off weight	33,000 lbs.
Gross wing area	1,314 sq. ft.
Wing span	90 ft.
Wing loading	25.1 lb./sq. ft.
Wing aspect ratio	6.16
Angle of sweepback (on 1/4 chordline)	24 3/4 deg.
Washout	5
Total area of fins and rudders	75 sq. ft.
Flap angle at take-off	25-30 deg.
Flap angle at landing	40 deg.

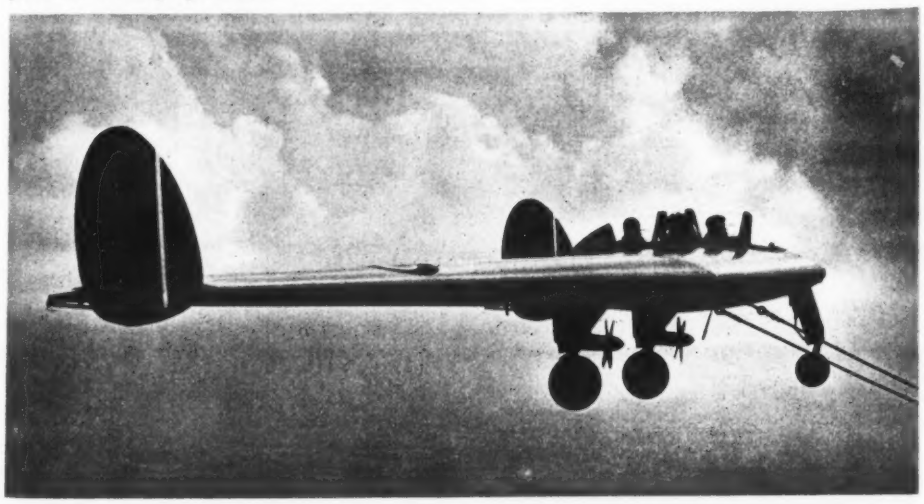
	Position of peak suction	Design lift coefficient	Tolerance on design lift	T/C
Wing section at root	55 %	0.2	± 0.3	15 %
Wing section at knuckle	55 %	0.1	± 0.3	15 %
Wing section at tip	45 %	0	± 0.3	15 %

England, as had the National Research Council in Canada and Northrop and Bell Aircraft in the U.S.A. In Germany Lippisch and the Horton Brothers had pursued the same policy before and during the War. Armstrong Whitworth, however, should be given credit for having been the only firm which went the whole way from the piston-driven aeroplane of orthodox design to the twin-jet powered tailless aircraft with laminar-flow wings, boundary-layer suction, corrector-elevon control with pressure-sealed control balances, thermal anti-icing and pressurisation for altitude flight, in three bold steps, i. e., wind-tunnel model, half-scale glider to full-scale jet aeroplane.

Quite a few considerations influenced the designer in favour of the glider policy. The wind tunnel gives static results only, whilst the glider enables dynamic tests and investigations of control to be made. Tests with the glider, even though it was only about half the scale of the powered version, could be executed at higher Reynolds Numbers than is possible with models. This is important, in view of the effect of Reynolds Number on maximum obtainable lift as well as on the shape of the lift curve. Thus tests in the slow tunnel were made at Reynolds Numbers of 5.10^5 first, followed by high speed tunnel tests at 4.10^6; whilst the glider allowed for work up to 14.10^6. The fact that a glider is less costly and quicker to build than a scale aeroplane was not so much the decisive factor as was the impossibility of finding an adequate small power plant. Stalling tests on a research aircraft require, for reasons of safety, a ceiling of preferably 15,000 feet. A supercharged engine would therefore have been necessary, and this would have been impossible to house in the wings. A tractor arrangement would not have been possible without disturbing the laminar flow, and pusher airscrews would have brought all the complications of shaft drives as well as cooling problems. All this was solved by using what is probably the last Whitley bomber still in action, to tow the glider to 10,000 or 15,000 feet, making use of the glider towing and testing technique developed during the War. Suction for boundary-layer control was provided by windmill-driven blowers (Fig. 4) and was applied to a slot in the upper surface at 0.4 chord from the leading edge. Two automatic observers register a large number of readings from flight instruments as well as from control force and angle indicators. There was, however, a further advantage obtained from the glider tests. They gave the test pilot a chance to familiarise himself with the flying characteristics of the new type and warned him and the designer of tendencies which might prove awkward. Only the glider tests brought to light an over-sensitiveness fore and aft, which was improved after the first flights by lowering the gearing of the elevons, and the experience obtained was applied to the design of the powered version. Had not such tendencies been disclosed to the test pilot and the designer during the glider tests, the first flight of the aeroplane might very well have been less successful than it was. I am convinced that the tragic loss, on its first flight, of an important airliner prototype of orthodox design, together with its crew, which is still fresh in the memory of all interested in aviation and which was due to overbalance of the elevator, would not have occurred had a half-scale glider model been tested first.

The preliminary work on the A.W. 52 glider included tests of general handling phugoid oscillations, wake traverse investigations, position error flights, pressure plotting, steady glides at trimmed speeds, lateral investigations, pull-outs from dives, flap and landing tests. As with all tailless aircraft,

Fig. 4 : A. W. 52 experimental tailless glider. Note the bifurcated towing arrangement and the windmills supplying power for boundary-layer suction.



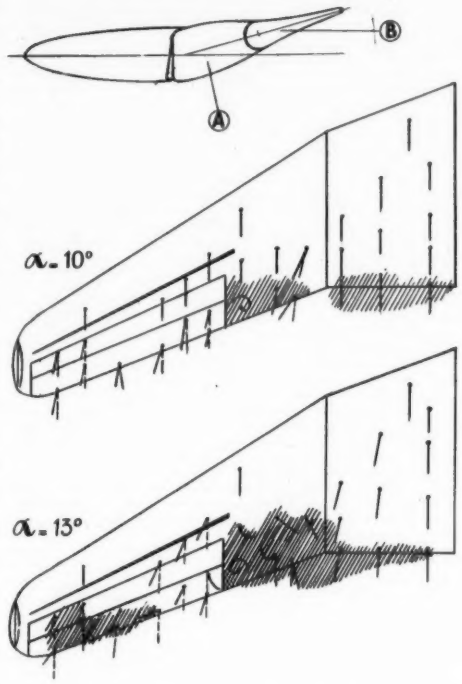


Fig. 5 : Influence of boundary-layer suction.
A = CORRECTOR.
B = CONTROLLER.
α = N. T. L.
Position of streamers :
(a) ——— without suction.
(b) ---------- with suction.
////////// denotes turbulence.

special attention had to be given to the prevention of wing-tip stall, which, with this type, produces not only loss of lateral, but also of longitudinal stability.

The effect of boundary layer suction, with and without corrector deflection, was therefore the object of a special series of tests. The correcting effect of suction on the outward flow of the boundary layer and therefore wing tip stall is shown in Fig. 5. Thus tip stalling was practically cured.

The laminar-flow wind-tunnel tests carried out by the National Physical Laboratory on a model of eight-feet span and six-feet chord were supplemented by glider tests, the glider section having a calculated transition point at 50 per cent. of the chord. As is known, the greater part of the parasite drag of a conventional type aircraft is produced by the body, tail unit and engine nacelle, plus interference drag. The glider tests confirmed that these sources of drag had been practically eliminated, and with the profile drag halved by the laminar flow construction, the total parasite drag of the powered version of the A.W. 52 should be between one half and one third of the usual value. This should be still better on a large tailless aeroplane such as the Northrop B-35.

It can be seen that the results obtained from glider tests more than justified the time and effort and money spent on its design, construction and testing.

The Air Hostess Told Us ...

Cabbages and Kings

Our gen emanates, as usual, from Esmeralda, our favourite air hostess. She affirms that such cargoes are not restricted to reigning and not-so-reigning kings hopping around in their own aeroplanes in darkest Africa and darker Europe, nor to princes running away from school in "Constellations," nor even to such rarities as solvent stock-brokers (they're reviving their flying club in England). No. Strange cargoes usually consist of higher or lower forms of animal and vegetable life, both live and dead.

Take Trans-Canada Air Lines, for instance, who in November carried 200 lbs. of live lobster to London for the Royal wedding. Or take the green peas that flew from Pennsylvania to New Jersey for canning in July. Nothing out of the way, to talk of cabbages and kings. What about the horses that are flown hundreds of miles to run a race and provide a spectacle for the multitude ?

But now we come to flabby stuff. In November, for instance, the Swedish ABA flew two hundred Hungarian frogs from Budapest to Stockholm. The Norwegian Vingtor Luftveiver charter company regularly carries dead, but fresh, fish from Trondhjem to Oslo, and the Russians are reported to fly daily cargoes of live fish from the Black Sea to Moscow and Leningrad. Why do these creatures clutter up expensive aircraft space ? Passengers might have been carried in their place. Let the fish swim and the frogs hop to their destinations.

Also, in November, the Danish DDL carried a polar bear, a leopard, monkeys, swans, geese and lots of little birds to Zurich and returned to Copenhagen with a lion, deer and several other varieties of our dumb friends. PAA and AOA report loads of repulsive snakes of various sizes, as well as thirty dachshunds from Germany. And in June, a Pacific Overseas Airlines aircraft carried a whole menagerie of three hundred animals, ranging from elephants to monkeys and wildcats, from the Siamese jungles to California. Esmeralda likes to assume there were no passengers. Here again, the brutes might have walked, crawled or flown by themselves. *We* have to walk to the office every morning.

Which shows that flying is widely used to make a dog's life tolerable. Well, dogs are claimed by AA to be amongst the nicest passengers you could care to have. On how nice they really are, we would not care to pass judgment in view of a report by Air France at the beginning of December stating that canines are more subject to airsickness than human beings ... or other animals.

How kind we are to our pets and pests ! How we ever had the heart to employ aircraft against locusts is a complete mystery.

Strange purposes ...

Aeroplanes seem to be used on a growing scale by people who go about their unlawful occasions as well as by those who are out to catch them.

Our favourite air hostess reports that one fine day fog clamped down on various Scandinavian airports, as a result of which a small aeroplane flying from Oslo to Göteborg was forced to land at Aarhus-Tirstrup aerodrome in Denmark. One passenger alighted—and was arrested by the police, who had long been looking for him for various reasons. No luck. There was also the much-publicised discovery in Denmark of a Nazi network which had specialised in the clandestine exportation of about two hundred scientists and ex-Wehrmacht officers from various Scandinavian airports to South America. Some luck.

Then there was the case of Julia Higgins and Christiana Torlania, two enterprising young American ladies, who operated a successful racket smuggling nylons by air from Belgium into France. The trade was so lucrative that, just before their arrest in July, they could afford to buy their own aeroplane and hire a pilot. Another smuggling affair was brought to light at the end of November when a Rumanian air-liner crashed in Czechoslovakia, which led to the discovery of a little hoard of gold bars, coins and jewelry weighing about seven pounds.

Equally profitable seems to have been a British organisation tracked down last June. For an average consideration of £500, this obscure concern offered to carry anybody who was in conflict with the Law from England to some point on the Continent. Queerly enough the operators of the scheme failed to realise when it was time to disappear themselves.

Apparently you can get away with almost anything for a little while. But illicit open-air transactions will gradually grow more difficult as the Law itself takes to the air In the Province of Buenos Aires an air police force equipped with five helicopters and eleven aeroplanes has just been formed to check smuggling and to perform other duties. A project is being studied in Finland providing for the use of aircraft to ferret out the many illicit liquor stills in Finland's forests. So, everything is going to be nice and legal and unexciting in the near future.

Esmeralda, who claims to have an open mind, says one should make use of some illegalities for the benefit of everybody. For instance, the Mexican police recently discovered twelve (yes, twelve !) clandestine airfields in the State of Sonora, near the U.S. border, which were used for the distribution of U.S. made narcotics throughout the Mexican Republic. Well, the Mexican Army destroyed the fields. Esmeralda thinks the racket should have been permitted to continue for a little while—Mexico might thus have received an up-to-date airport system free, gratis and for nothing.

Bl.

Economic Aspects of the American Aviation Industry

VII *

The problems of the United States air transport industry were further complicated during November by the voluntary grounding of the DC-6 for thorough inspection of the electrical, hydraulic, fuel, oil, heating and ventilating systems, and other equipment, which was scheduled for completion by December 1st, 1947. Preliminary investigation of the United Air Lines crash near Bryce Canyon, Utah, on October 24th, and the emergency landing of the American Airlines DC-6 on November 11th, indicate that an overflow of fuel may have entered the air scoop and become ignited by the cabin heater.

The emergency grounding of the DC-6 is reminiscent of the grounding of the "Constellations" in the third quarter of 1946. TWA, however, had a pilot strike in addition, which was very costly and accounted for the deficit of nearly $9.5 million for the third quarter and a full year's loss in 1946 of $14.3 million. Nothing as serious as this is expected by the airlines using the DC-6. At the time of the grounding both American and United had the better part of their 50 and 35 DC-6's, respectively. It is too early to determine the resultant loss, though around $1 million has been estimated for each company. After reasonably good third-quarter reports for both American and United, this grounding will, in all probability, change what had been expected to be moderate profits for the fourth quarter, into losses.

The grounding of the DC-6 may temporarily help T.W.A. in its competition with United and American for the coast-to-coast traffic. For the third quarter of this year T.W.A. had revenues of $23.4 million, against $17.2 million a year ago. Net profits were $884,000 or 90 cents a share on the common stock, against the large loss in 1946. Analysis of the company's operating figures seem to indicate that the new budgetary controls introduced by the present management are producing results. In the first quarter of this year the T.W.A. cost per ton-mile was the highest in the industry. Expense figures were pro-rated among the departments and definite cost cuts were instituted. As a result, in September T.W.A. revealed a net operating income of $747,000 on a load factor of 74 per cent. However, T.W.A., as well as most of the other airlines, with the exception of Eastern and National, are coming into the poor flying period when traffic usually runs well below the seasonal peaks of August and September. For example, United Air Lines' revenue passenger-miles reached a peak of 141 million for August and about the same in September. On a preliminary basis, October should show around 130 million revenue passenger-miles. November will be seriously reduced by the grounding of the DC-6, but there should be some modest recovery in December if this airliner gets back into service and if flying weather is reasonably good. January and February usually constitute the worst seasonal period and only 80 million revenue passenger-miles per month for United eem to be in prospect, less than 60 per cent. of the August seasonal peak.

With few exceptions the airline industry is applying for higher mail pay and higher passenger fares. The principal holder-out is American Airlines, but there are indications that a 10 per cent. increase in passenger rates would not be as unacceptable to this company as might be thought from earlier statements. It now appears that passenger fares will be increased throughout the industry by 10 per cent., probably about next March.

United Air Lines has applied for mail pay at the rate of $2.26 per ton-mile, retro-active to January 1st, 1947, and for 1948 has asked for a rate of $1.25 per ton-mile, compared with the current 45 cents per ton-mile. The supporting data show constantly rising costs of operations plus a decline in mail loads. The company estimates its 1947 mail volume at 9 million ton-miles, contrasted with the war-time peak of 20 million ton-miles. In this same testimony United estimated an operating loss of $2,531,000 for the whole of 1947, compared with $2,179,000 for the nine months up to and including September. This testimony was introduced after the grounding of the DC-6 and apparently signifies a net operating loss of $350,000 for the fourth quarter, which compares with an earlier estimated profit for the fourth quarter of around $600,000 prior to the DC-6 grounding. The sum of these figures, $950,000, clearly corresponds with our estimate mentioned above of approximately $1 million loss for United and about the same for American as the result of the DC-6 grounding.

In the testimony before the C.A.B., United Air Lines indicated that it felt the airlines should be allowed a return of about 10 per cent. on investment. The mail and passenger rates requested are based on traffic forecasts about sufficient to return such a profit. United's investment rate base is estimated at about $80,000,000. The rate base includes the book value of flying equipment, ground facilities, investment in ticket offices, etc. Also included is a reasonable amount of working capital based on a figure of about three months' operating expenses. Excluded from the rate base are certain intangible items and the investment in subsidiaries such as the Mexican company, LAMSA. The 10 per cent. figure is, of course, after taxes, but before debt interest and preferred dividends ; if granted it would amount to around $8 million, or a little over $4 a share on United Air Lines common stock. As to the question of 10 per cent. earnings on invested capital, a previous decision by the C.A.B. indicated that a 12 per cent. return was not unreasonable. A clear-cut expression of what is a reasonable rate of earnings for the airlines would help to clarify the confused picture presented by the domestic airline industry.

* Cf. "INTERAVIA, Review of World Aviation" Vol. II, No. 11 for report No. VI

The following table shows recent earnings and market prices for the principal air transport companies.

	Net per Share Sept.	Net per Share 9 months incl. Sept.	Operating Rev. 9 months incl. Sept. compared with 1947	Current Market Dec. 1	Range 1947
American Airlines	$0.09	d $0.32	+ 29.4 %	7 5/8	11 3/8—7 1/2
American Overseas	d 0.08	d 0.97	+ 46.3 %	8 3/8	3 5/8—6 3/4
Chicago & Southern Airlines	0	d 1.32	+ 10.6 %	5 1/4	8 3/8—5 1/4
Continental Air Lines	d 0.04	d 1.10	— 16.8 %	7	10 1/4—6 3/8
Delta Air Lines	d 0.01	d 0.37	+ 10.8 %	16	25—15
Eastern Air Lines	d 0.13	0.46	+ 29.2 %	17 1/2	24 1/4—16
Inland Air Lines	0.06	0.41	+ 22.7 %	3	4 1/2—2
Mid-Continent Airlines	0.12	0.22	+ 15.0 %	6 1/4	8—5 7/8
National Airlines	d 0.23	d 0.80	+ 19.9 %	9 1/2	16 1/2—9 1/2
Northwest Airlines	0.17	d 1.29	+ 32.6 %	11 3/4	22 1/4—11
Northeast Airlines	d 0.15	d 1.84	— 7.7 %	3 1/8	7 3/8—3
Pennsylvania-Central Airlines	0.70	d 5.78	+ 4.8 %	6 5/8	15 1/2—6 1/4
Transcontinental & Western Air *	0.63	d 4.64	+ 21.3 %	15 3/4	22 7/8—13 1/2
United Air Lines	0.34	d 0.93	+ 25.3 %	17 3/8	28 1/2—16 7/8
Western Air Lines **	2.42	2.32	+ 15.5 %	6 3/4	10 1/8—5 3/4
	Oct.	10 months incl. Oct.	10 months incl. Oct.		
Braniff Airways	0	d 0.80	+ 6.7 %	8 1/8	13 1/2—8
	Aug.	8 months incl. Aug.	8 months incl. Aug.		
Colonial Airlines	d 0.02	d 1.32	+ 2.2 %	7 3/8	11 3/4—7

d Deficit * Includes foreign operations
** Includes non-operating income of $1,788,364 from sale of Denver-Los Angeles route to UAL.

Consolidated Vultee is offering shares of Nashville Corp. stock, a new subsidiary formed to hold the 48 per cent. interest in ACF-Brill Motors Co., the general non-aviation manufacturing interests at Nashville, Tennessee, and stock holdings in Eastern Massachusetts Street Railway. The plan gives Consolidated Vultee's stockholders the right to buy two shares of Nashville stock for each four shares of Consolidated Vultee stock owned, by turning in one share of Consolidated vultee stock, which will be cancelled, and paying $18.50 in cash. The new company will have a capital made up of 800,000 shares. Consolidated Vultee will receive about $6 million in cash and its holdings will be reduced by 411,000 shares, or 25 per cent. The AVCO Manufacturing Company has indicated that it will take up any unsubscribed shares in Nashville, in effect relinquishing most of its stock holdings in Consolidated Vultee (previously 26.1 per cent.) and relinquishing management control. At the same time, Mr. Odlum, President of Atlas Corp., announced that his firm would not exercise its rights to buy the Nashville stock and would in effect increase its holdings in Consolidated Vultee from 7.5 per cent. of the total outstanding, to 10.1 per cent., thus becoming the largest single stockholders. The Atlas group will assume management control and Mr. Odlum will become Chairman. This change in control marks another step in AVCO's withdrawal from the aviation industry. Atlas Corp. also owns 100,000 shares in Northeast Air Lines, which is over 12 per cent. of the outstanding stock and apparently represents effective control.

The willingness of Atlas Corp. to take a larger stake in the aircraft manufacturing industry seems significant in view of the immediate problems of the industry. Douglas Aircraft Company, for example, because order backlogs are dropping rapidly, now employs only 9,000 as against 160,000 at the war-time peak, and expects to have only 3,000 workers by early next summer. Lockheed's personnel has been reduced to 12,000 from a peak of 94,000; however, present orders should keep this level of employment until early 1949. In spite of the current problems of the manufacturing industry, prospects for future business are being clarified. For example, tests on North American Aviation's new jet-propelled P-86 have been successfully completed and production is expected to start shortly after the first of the year. Fairchild Engine & Airplane Corporation has received an order from the U.S. Air Force, involving about $22 million, for 37 units of the new Model C-119 freighter, a development of the C-82 "Packet," which is capable of carrying a 9-ton payload. Boeing's better than average position is illustrated by the fact that the company has placed a number of sub-assembly contracts for both "Stratocruisers" and B-50 bombers in an effort to speed up delivery. Boeing has added about 3,500 to its payroll, and is expected to bring the total figure to over 17,000 by the end of the year.

Mr. Damon, President of American Air Lines, estimated in testimony before the President's Air Policy Commission that the aircraft manufacturing industry would secure, in commercial orders, from $100 million to $125 million business annually for the next five years. He estimated further that the industry needed a rock-bottom minimum of $750 million a year overall. Evidence is accumulating that the Government authorities are preparing to take vigorous action to assure an active and healthy aircraft manufacturing industry. The Secretary of the Air Force has stated that the Air Force needs an annual procurement of 3,200 aeroplanes to maintain the "70 group" programme which the department regards as a minimum air defence establishment. The "70 group" plan contemplates 6,869 units for the active air force, 2,360 for the Air Reserve and 3,212 for the National Air Guard, a total of 12,441 aeroplanes. Furthermore, he stated that a reserve of 8,100 was necessary and that over a five-year period the purchase of 5,295 aeroplanes was needed, in addition to the 3,200 annual procurement.

* * *

The problems of the personal aircraft industry are still acute, however, as is illustrated by the decision of Republic Aviation Corp. to close out its private aeroplane activities entirely by selling all its spare parts for the "Seabee" if possible. Personal aircraft shipments reported by thirteen companies during October were down to 877, with a total dollar value of $3,117,000, compared with figures for the ten months up to and including October of 14,672 units, worth a total of $48,286,000.

The following table shows interim earnings for several airframe manufacturing companies, together with latest available working capital figures and prices.

December 1st, 1947.

Baker, Weeks & Harden,
Wall Street,
(Jeremy C. Jenks).

		Latest reported earnings per share	Latest reported * net working capital per share		Dividend paid or declared in 1947	Current market Dec. 1st.	Range 1947 High	Range 1947 Low
Beech	Year to Sept. 30th.	d $4.54	$10.60		$0	8	12	5 5/8
Bell	9 months to Sept. 30th.	d 0.87	25.60		1.00	14 1/4	18 1/4	10 7/8
Boeing	9 months to Sept. 30th.	d 0.33	40.30	(12/31/46)	1.00	21 7/8	24 1/8	14 1/8
Convair	9 months to Aug. 31st.	d 3.99	22.50 **	(7/31/47)	0.50	12 3/4	17 7/8	10 1/2
Douglas	9 months to Aug. 31st.	d 1.95	93.70		2.50	49 1/2	76	45 1/4
Grumman	6 months to June 30th.	2.62	37.30	(12/31/46)	3.00	31 1/2	32 3/4	17
Lockheed	6 months to June 30th.	d 4.54	17.10		0	12 1/2	20	10 5/8
North American	9 months to June 30th.	0.08	10.65	(9/30/46)	0.50 (plus stock)	8 7/8	10 3/4	6 5/8
Republic	9 months to Sept. 30th.	d 0.96	4.78	(12/31/46)	0	8 1/8	9 7/8	4 3/8

* As of same date as earnings unless otherwise indicated.
d Deficit
** Pro forma reflecting Nashville sale

Mañana por la mañana

Failure of the ICAO Conference to establish a Multilateral Agreement on Commercial Rights in International Civil Air Transport.

Geneva, November 4th to 26th, 1947.

"Death-chamber of the Multilateral Aviation Agreement." The ICAO Commission's conference room viewed from the press gallery.

I. *In the Death-Chamber of the Multilateral Air Agreement.*

From the press gallery one looks down upon the many seats in Committee Room VII of the Geneva Palais des Nations. The room is dominated by a dais against the far wall : on it are seven unoccupied red-leather-upholstered "seats of judgment." Have they perchance been reserved for Chronos, the god of time ? The negotiations have been dragging along for three weeks and are heading towards an impasse. The first words which strike my ear upon entering the room are spoken by the Spanish interpreter : "Mañana—Tomorrow." He pronounced them softly, rather sleepily. "Mañana" : one is unfortunately tempted to complete the saying : "Mañana por la mañana," which is Spanish for "Let's put it off until tomorrow," thus internationally significant of something which will never come to be.

One does not need to seek hard for an epigraph to the ICAO Commission's efforts to bring about a multilateral agreement on commercial rights in international air transport : "Mañana por la mañana" has it in a nutshell.

It was another abortive conference... Why waste a lot of words on it ? Why get excited ? Nowadays, we are pretty used to seeing international meetings falling flat—unfortunately. And anyhow, the matter at stake was only of secondary importance, a "purely technical" problem in international commerce, which, though interesting to a few experts, leaves the man-in-the-street quite cold. In principle, Bill Atkinson over his pint of mild, Jacques Durand savouring his *café noir* and Gumersindo Antúnez sipping his *copita de malaga* don't care two hoots whether aircraft load and unload on the basis of a multilateral agreement, or whether States have to conclude bilateral pacts with each other. That's the business of airline companies and aviation authorities ; and as far as they are concerned, "A little work from time to time wouldn't do the high-up's any harm, either."

Well, here's a solemn reminder to Messrs. Atkinson, Durand and Antúnez that the whole show does affect them, in that it directly affects their own purses. When thousands of diplomatic missions have to be paid for, which could be avoided ; when one office after another has to be furnished, for the execution of highly superfluous work ; when customers, salesmen, goods and mail arrive at their destination several days late ; when aircraft are prevented from flying—then it is not the various national ministries that have to bear the brunt of higher prices, increased taxes, augmented transportation costs... In international conferences, it is always the money of Messrs. Atkinson, Durand and Antúnez which is at stake.

II. *The Apparent Causes of the Failure.*

To all appearances, it came like a stroke of lightning from a clear blue sky. The Drafting Committee and Plenary Sessions had worked expeditiously. Questions of rates, capacity, arbitration, and a whole series of other matters had been settled calmly and unambiguously. In general, there were hopes that the deliberations would come to a successful close around the last week of November, with the conclusion of a multilateral agreement. On November 23rd, meanwhile, the U.S. delegate proposed the insertion of a new article in the chapter on Authorisation of Air Routes, to the effect that :

> "If a Route Agreement authorises stops in the territory of States other than the parties to the Route Agreement, such Agreement shall, subject to the conclusion of appropriate Agreements with such other States, also authorise taking on and putting down international traffic destined for or originating in such other States (Fifth Freedom—Ed.) under the conditions of Chapter III (Capacity) hereof."

Let us leave aside as to whether the U.S. formulation was well chosen or whether it was editorially adroit to join this question to the chapter on air route authorisation. There is no disputing the fact that the proposed text was tantamount to U.S. recognition of the Fifth Freedom (cf. *Interavia Review* Vol. II, No. 12 : "Ink or Fuel"), even if this would be severely limited by the clause relative to capacity and by the possibility of route agreements' failing at any time.

At all events, the U.S. proposal had the effect of a bomb. It would perhaps be more exact to say that a bomb exploded, of which the fuse had begun to sizzle during the earliest stages of the conference. Already on the second day of the negotiations, the Indian delegate proposed that contracting States be empowered to forbid the operation of a route which had been authorised, until the decision of the arbitrary tribunal was forthcoming. One may infer from this attitude that certain powers would repugn a too generous definition of traffic freedom and would not be willing to allow their securities to be wrested from them completely.

"Frankly, I'm worried..." The Hon. Garrison Norton, Assistant Secretary of State and Head of the U. S. Delegation (left), talking to the Vice-Chairman of the U. S. Delegation, the Hon. Oswald Ryan, Vice-Chairman of the U. S. Civil Aeronautics Board. On the right is Professor Edouard Amstutz, the Swiss Government's Delegate for Civil Aviation, who presided over the session with prudence and impartiality.

The delegate of Mexico, supported by the delegates of Portugal, Egypt, Greece, Italy and India, proposed the insertion of a new article which was diametrically opposed to the U. S. suggestion :

> "Nothing in the present Agreement shall prevent a Contracting State from entering into a Route Agreement which will only grant to another Contracting State the privileges of taking on and putting down international air traffic originating in or destined for the other party to the Route Agreement (Third and Fourth Freedoms—Ed.) and not the privilege for the carriage of international air traffic both originating in and destined for points on the agreed routes in the territories of States other than the parties to the Route Agreement." (Fifth Freedom—Ed.)

Translated from legal jargon into everyday language, all this signified that the Americans wanted to prevent the bilateral route agreements from subsequently, by a round-about way, torpedoing anew the Fifth Freedom (right to transport passengers, freight and mail from the territory of any contracting State to that of any other contracting State) guaranteed by the multilateral agreement. The counter-proposal wanted to keep dry the powder of the bilateral route agreements in readiness for torpedoing the principle agreement.

The motives of the States upholding the Mexican proposal were certainly not uniform. Australia, Canada and New Zealand probably took sides with them merely in order to prevent the conference from failing and—cost what it may—to arrive at a multilateral agreement. It is possible that other countries had contrary interests.

Be that as it may, on November 24th the specialists ascertained the death of the patient, and thereupon their task could have been finished. The delegations could have gone home. However, they did not go home, but conferred for two more days and one night (the negotiations of November 26th lasted until one o'clock in the morning).

"Optimism reigned at the beginning..." Left to right: Dr. Edward P. Warner, President of ICAO Council; Mr. W. C. G. Cribbett, Deputy Secretary, Ministry of Civil Aviation, and Head of U. K. Delegation; the Hon. Oswald Ryan, Deputy Head of U. S. Delegation.

"Who would have thought it... ?" Mexican Delegation (left to right): Engineer Armando Santacruz (Vice-President of LAMSA), Mr. Manuel Palavicini (President, Mexican Securities and Exchange Commission, and Head of Delegation), Mr. Rafael Paz-Paredes (Head, Office of International Civil Aviation).

A lunch offered by the Geneva State Council at the "Perle du Lac" manages to soften the most inflexible opponents: left: Mr. Jules Peney, President of the Administrative Council of the City of Geneva; Mr. H. Berglund, Head of the Swedish Delegation and (fourth from left) Mr. Alf Heum, Head of the Norwegian Delegation, both indefatigable champions of the Freedom of the Air. Between them: Dr. Boris Lifschitz, Head of Nicaraguan Delegation; Mr. Tombet, Geneva State Chancellor (second from right); Mr. R. R. Mathieu, Chief of the ICAO Conference Section (extreme right).

The French delegate had suggested that, in its Final Report, the Commission emphasise the points of litigation which had caused the conference to fail. It was better to admit one's differences of opinion frankly than to embellish and veil them.

The Assembly agreed to this very praiseworthy suggestion and clearly embodied, in points 12 and 16 of the Final Report, where the reasons for the conflicting views are to be sought.

But, in addition, the conference went on to discuss point by point—after its definite failure—the very draft agreement it had killed, in order to show exactly on which points agreement had been attained. Amidst feverish activity there arose what one might call a "mock-up draft." The idea in mind was not to allow the theoretical results to disappear altogether, and to preserve a basis for later conferences.

From the psychological standpoint, it seems perfectly understandable that the delegates did not wish to annul three weeks of hard and zealous work with a mere stroke of the pen. Then, again, the "Recommendations to Member States" in points 17 and 18 of the Final Report do not seem to promise much success. In point 6 of the Report, the Conference declares itself that the question of the Fifth Freedom cannot be separated from the questions of route authorisation and capacity. On what can one base hopes that certain suggestions —gleaned from the rejected project—can find general acceptance in the face of this recognition ?

De mortius nil nisi bonum. Nevertheless, the conference in Geneva did not die elegantly.

III. *The Autopsy*

Heaven forbid that we be asked to give readers a complete account of the "platonic recommendations" made at this conference and try to state, wherever possible, in what measure the chimerical "approaches" represent "progress" as compared with earlier projects for agreements. Anybody who is acquainted with the normal course of international negotiations knows perfectly well in which basket "motions" of this sort are usually filed.

On the other hand, it seems important that we should briefly investigate the real causes leading to this regrettable lack of agreement and consequently to a further garrotting of international civil aviation.

From the *juridical standpoint,* the matter is simple. This draft of a draft gives each contracting State the right to refuse to conclude a route agreement at any time *without giving any specific reason.* This condition alone would have sufficed to rob an eventual multilateral agreement of its binding power. Even the attempt to regulate the Fifth Freedom entirely or partially on the basis of bilateral route agreements would forcedly have devaluated a multilateral agreement. Any normally-educated student of international public law will—provided he has no political or economic prejudices—admit that a principal agreement on to which accessory agreements have to be grafted, must itself contain all the essential elements of the contract; later auxiliary agreements may only interpret the main agreement's conditions for particular cases of application. As regrettable as may be the failure in itself, it is perhaps a blessing that no agreement was ratified which disregarded this fundamental principle of drawing up contracts. A failure of the multilateral agreement at the hands of practical experience might have been more harmful to air transport than the continuation of the present situation.

Politically, the conference in Geneva was as instructive as it was painful. Granted that the importance of aeronautical dealings cannot be compared with that of the big international conferences which decide the destiny of our world. Nevertheless, the Freedom of the Air is scarcely a problem of altogether secondary significance. But, above all, these negotiations in Geneva, to which little attention was paid on the whole, constituted a touchstone. Russia has held her distance from ICAO ever since the latter's formation. Spain was ousted from the Organisation in May, 1947. The conference in Geneva was therefore held, to a certain extent, "under optima conditions." Its failure demonstrates that countries cannot find agreement even when all the higher political obstacles have been eliminated.

Our forefathers established international laws and formulated claims because the nations they represented wanted to live. It seems that we are approaching an era where the nations only want to live in order to be able to establish laws and formulate claims. In the long run, this state of affairs is liable to become harmful not only to civil air transport, but also to all the other interests of the nations. It is only to be hoped that they will not pursue these unhealthy maxims to a point where the latter will turn against them.

The second lesson might be that ICAO's incorporation in the United Nations Organisation has infused politics into international aviation. One is tempted to opine that aeronautical questions ought to be solved by aeronautical specialists who, if needs be, could enlist the aid of lawyers and diplomats. The reverse procedure might be taken badly by aeroplanes; they could start "butting" each other.

The *economic aspects* of this unfortunate conference were superabundantly illustrated by the Colombian delegate in his brief statement of November 24th. His use of the term "horse trading" might have been a little severe; but it hit the nail on the head. We can add only one remark to his declaration: to want to conclude a business deal is no dishonour; but to veil one's desires in ethical principles seems inappropriate. If certain States wish to "sell" the Fifth Freedom of the Air for lucrative gains, then let them come right out with their prices, without further ado. There are sufficient other occasions on which to carp on "democracy," "justice," "international ethics" and suchlike.

He.

There's No Place Like Home!

According to the press, it appears that the foremost of Hollywood's heart-breakers, Tyrone Power, on the occasion of his recent flight to Africa, where he visited seventeen countries, had to fill in no less than twelve thousand forms, manifests, questionnaires and declarations.

Intrepid voyager as he may be, Ty's enthusiasm for seeing the world must certainly have been curbed a little by this dose of red tape. He will probably agree, by now, that there's no place like home ; despite the fact that an actor's first duty is never to stay immobile, but to keep incessantly on the move.

Unfortunately, Tyrone Power is not the only person afflicted. I am at a complete loss to diagnose what has been the matter with human beings for quite some time : they just can't keep still. All over the world, doctors are racking their brains to find cures for cholera and cancer. It might not be such a bad idea at that if they tried to rid humanity of its chronic travel fever.

There might be an excuse if one found any allurement in the countries one visits. As it happens, the other country is either just as miserable as one's own, so that the whole trip has just been a waste of time and money ; or else it is literally flowing with milk and honey, in which case one is envious and discontented with one's own lot. The best thing is to stay at home. The story of Ulysses, incidentally, ought to constitute a warning to over-enthusiastic travellers : notwithstanding their zeal for knitting, can one be sure that every wife is a Penelope ? On the other hand, the modern husband has not cultivated the habit of stopping up his ears with wax so as not to be lured by the sirens' song.

Of course, it's just a waste of time telling people. They want to move around from one country to another, crossing continents and oceans in the search for something new to satisfy their undeveloped imaginations.

In any case, all those who have travelled a lot will have appreciated the perfect coincidence among the customs, police and other official controls. Whether one lands in the tropical swamplands, the frozen steppes or the dusty pampas, there is always the same pile of formalities, the same baleful eye of the official who regards you as a suspected person from the start. Since you are travelling around, it means that you don't feel easy about something . . .

"What's the reason for your journey ? Where are you bound for ? Who is expecting you ? What's your profession ? Let's see your nose . . . Hm ! a bit squat. Your eyes ? . . . Green, I'd call it. Your mouth ? . . . Nothing special. Where did you get that scar on your shoulder ? . . . Street-brawl, I'll bet."

They don't miss a single detail. Exasperated by their cavilling, a pal of mine who was asked to explain how he got a scar above his left eyebrow retorted, "I have a bad habit of biting myself in the eye when I'm asleep." The remark was rewarded with laughter from his fellow-passengers, but he didn't get his passport back for a while.

And the passport photo. One is lucky if one hasn't to return twenty times to the photographer before the "full-face" view satisfies the authorities. The photographer's "Keep still now !" ought to be heeded from the start.

There is the case of another friend of mine who had to dictate the answers to a lengthy questionnaire. All seemed to go well at the beginning, until suddenly the bearded official asked :

"Son of the late ? . . ."

"Bbb . . ut ! my parents aren't dead "

"Answer my question Son of the late . . . ?"

"But I'm telling you that my parents aren't dead "

"I didn't ask you that Son of the late . . . ?"

" ? ! ?"

"All right then. Withholding information. You won't leave."

My friend had to give up the idea of travelling. He couldn't very well have murdered his parents just to be able to fill in the questionnaire correctly.

We have all had our experiences with the authorities. I got my fill of them once when I ventured to cross the French frontier to visit Switzerland. Now, as you know, Switzerland is a delightful country ; one to which everybody likes to return, including myself, if it weren't for the exchange nightmare. Well, on my trip, I did happen to have a few pieces-of-eight to play with, which I expended on chocolate and tea. For some mysterious reason I have never addicted myself to smoking, so that I hadn't a single grain of tobacco in my suitcase on the way back. The French customs official, examining my luggage, seemed to be pretty satisfied until, at the moment when he was going to chalk the cross of freedom on my suitcase :

"How many cigarettes ?" he asked, rather amiably

"Not a single one."

At this, his face discarded its jovial expression.

"I asked you, how many cigarettes ?" he repeated, testily.

"Frankly, I haven't a single one."

He turned scarlet.

"So, that's the game, is it ? You'd better come with me."

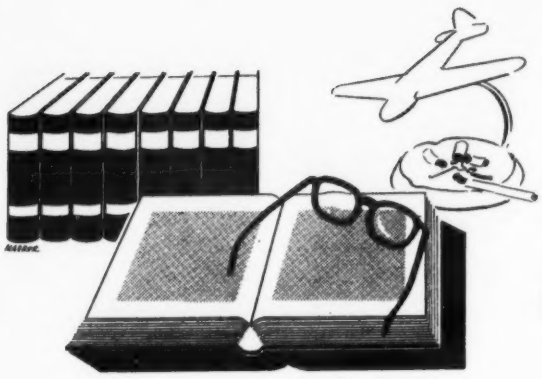
What followed is still vivid in my memory. Never have I been subjected to such a thorough corporal examination. Stripped to the skin . . . words fail me.

It would seem as though the most devout abstainer from smoking can become a victim to nicotine.

My opinion of the customs formalities, as you may imagine, is unprintable.

Here's another instance. Seventeen years ago I did my military service in Algiers. One Sunday, in the tumult of the fruit market, a pickpocket snaffled my wallet. And this wallet contained my passport which I needed for a student trip to England. Either the fellow used it himself or he sold it to some other crook, so that it is quite possible that, at this very hour, Grosrichard Yves, born in Paris on Saint Catherine's Day, 1907, is featured in some official rogues' gallery as the author of a respectable number of burglaries, robberies with assault and battery, supplemented by two or three instances of general debauchery. I am prepared to plead my case any time the authorities choose. But when I do, I shall certainly call as witness for the defence, the individual who invented passports.

Yves Grosrichard.



Book Reviews

L'Homme qui donna des Ailes au Monde.

By Louis Castex, Published by Plon, Paris, 1947.

Did Clément Ader really fly ? Was he the first, in 1890 and 1897, to become airborne in a heavier-than-air aircraft ? This old controversy has recently been revived in France, after even such sceptics as Henri Bouché and Charles Dollfus had for some time chosen to embrace the ruling opinion on this flight.

The title of his book clearly indicates on which side the author is. He writes with that sacred enthusiasm of a Frenchman who desires to secure the historical priority for his country. He does not give any really new proof, and this would be a difficult task anyhow, since the pros and cons have been discussed too thoroughly in the course of the years.

The value of Castex's book does not lie in this new grouping of facts, but in the conversational style in which he portrays Ader's personality. The reader does only learn of what Clement Ader achieved—or did not achieve—but, above all, he makes the personal acquaintance of one of the most outstanding denizens of the realm of world aeronautics. He watches Ader grow up in his southern French home and, after a hectic career of disappointments, return to it. Castex's book is to be recommended to all who seek other things in aviation history besides dates and tables. (French.) *He.*

Gliding and Advanced Soaring.

By Ann C. Douglas. Published by John Murray, London.

Mrs. Douglas confines herself to the practical side of soaring, drawing upon her wide experience as a pilot and soaring club operator in the chapters on launching and instructional methods, club operation, design of sailplanes, construction, maintenance and repair, available sailplane types, glider equipment and accessories (trailers, etc.), and well-known soaring centres. *Dr. A. E. Slater,* formerly editor of *The Sailplane and Glider,* deals with such subjects as the history of soaring and meteorology, whilst *P. A. Wills,* holder of the British height, distance and goal flight records, describes the problems presented by cross-country and altitude soaring. The book is written for people who want to take up gliding and soaring and avoids abstruse technicalities. A disadvantage may be the fact that it seems to be intended chiefly for British readers. — Fully illustrated with photographs, diagrams and two maps (of England), "Gliding and Advanced Soaring" demonstrates that since the days of Otto Lilienthal sailplane flying has developed into a fascinating art which requires a knowledge of a variety of subjects if it is to be fully enjoyed. (English.) *Bl.*

Jane's All the World's Aircraft, 1947.

Compiled and Edited by Leonard Bridgman. Published in Great Britain by Sampson Low, Marston & Co., Ltd., London ; in the U. S. A. and Canada by Macmillan Co., New York, and Macmillan Co. of Canada Ltd., Ontario.

The 1947 edition of this well-known reference work, as in previous years, deserves the attention of all aviation circles. As usually, it is divided into four parts—Service Aviation, Civil Aviation, Aeroplanes, Aero-Engines—and it is notable for its complete information on so many items shrouded in official secrecy until quite recently. In a total of 446 pages, 630 illustrations and G. A. drawings, this year's "Jane's" lives up to its reputation as a thoroughly reliable record of world aviation. (English.) *Ba.*

Le Développement moderne de la Théorie de l'Hélice

By Raymond Siestrunck, Published by Gauthier-Villars, Paris, 1947.

In about 100 pages the author, at present working for the Mechanics Institute of Paris University, deals with all the knowledge of potential flow on airscrews so far obtained on the basis of the vortex theory. Beginning with the history of and conditions to the theory, he then goes on to examine the vortex field and the speeds induced by the airscrew, and subsequently introduces these into basic equations for circulation, thrust and moment. For the solution of these, Prandtl, Goldstein, Lock, Kawada, Valensi, and others, have submitted approximation methods, which the author deals with in brief. With the aid of these methods the most favourable distribution of circulation along the blade is obtained and, finally, the most advantageous airscrew dimensions for a given operating condition. The clear description, elegant in its brevity and compactness, sets as primary requirement, a mastery of theoretical aerodynamics and their mathematics, but also shows how results of practical utility can be calculated. These results are to be published shortly in the author's doctor-dissertation, "Ecoulements à potentiel dans les machines hélicoidales simples." (French.) *T.*

The Elements of Aircraft Propeller Design.

By F. T. Meacock. Published by E. & F. N. Spon, Ltd., London, 1947.

The author of this recently-published book does not only address himself to qualified circles. Thanks to the simplicity and lucidity of the text, it is equally suitable for generally technical-minded people who wish to acquaint themselves with the fundamentals of the aerodynamics and design of propellers.

Divided into four sections, the first deals with the basic principles of propeller aerodynamics ; the second section is primarily devoted to the design aspects, describing, in some detail, the main propeller types in use today. Starting with fixed-pitch two-blade propellers, Meacock goes on to multi-bladed c.p. types, contra-rotating assemblies, finally to discuss airbrake and landing-brake propellers. Alongside the constructional details of various pitch-control mechanisms, the third section deals with the most important questions relating to hub and blade design. Numerous diagrams, graphs and illustrations are grouped to form the fourth section. (English.) *Ba.*

Le Groupe de Bombardement Tunisie.

Published by Berger-Levrault, Paris, 1947.

There is no current lack of literature on war souvenirs and heroic episodes. If this campaign history of the French bomber group I/25 "Tunisie" contained nothing else besides a description of 1,145 combat operations over Tunisia, France and Germany, it would not be worth reading—notwithstanding the existence of certain sensational episodes. Meanwhile, however, the book *is* worth reading, because it gives a striking picture of the particular position in which the French airmen were during the war. The members of bomber group I/25 were regular French soldiers. But it was only after great efforts, long waiting, and struggling against Allied mistrust that they were able to join their countrymen in Africa, carry out their additional training in England and later reach the German war theatre. The fact that the authors had to revert from their regular soldier status to that of volunteers in order ultimately to become regulars again makes their collective souvenirs very good reading. (French.) *He.*

Car la Terre est ronde.

By J.-M. Accart. Published by B. Arnaud, Grenoble and Paris, 1947.

General Piollet, in an introduction to this short brochure, explains that the author has taken "*si vis pacem para pacem* — if its peace you want, then prepare for peace — as his motto. However, the book speaks of preparations which can hardly be called peaceful : atomic and bacteriological weapons, supersonic combat planes, rocket firing ramps. After the pattern set by the Italian Chief of Staff and air strategist, General Ginglio Douhet, the author champions the development of an up-to-date strategic air arm for France. Moreover, Accart calls for an abolition of the Army and Navy.

Meanwhile, these altogether not too peaceful preparations should all the same serve to preserve peace, in that they would enable France to preserve an armed status of neutrality in the event of a future world conflagration. (French.) *He.*

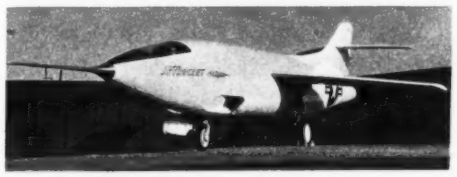
THE MONTH IN REVIEW

Copyright by INTERAVIA *

POLITICAL

● CIVIL AVIATION AGREEMENTS were concluded between Norway and Portugal, in Lisbon on November 11th ; Brazil and Denmark ; Norway and Sweden, in Rio de Janeiro on November 14th ; Denmark and Greece, on November 15th ; Italy and Ireland ; Ireland and Denmark.

NEW AIRCRAFT



Douglas D-558-2 "Skyrocket."

● Douglas Aircraft Co. has just completed a new experimental high-speed aeroplane, the *Douglas D-558-2 "Skyrocket,"* at its plant at El Segundo, Calif. In collaboration with the National Advisory Committee for Aeronautics (NACA), Douglas started work on this project under contract to the U.S. Navy in the summer of 1945. The "Skyrocket" is exclusively for test purposes and thus has no armament. It is an all-metal, mid-wing monoplane with sweptback wing incorporating Handley-Page automatic slots in the leading edge to give improved low-speed lift characteristics. The tail also has pronounced sweepback. The aerofoil sections are of the conventional subsonic type. Purpose of the "Skyrocket" is to explore the upper limits of this type of aerofoil which permits relatively normal low-speed characteristics to be retained. The slim, tapered fuselage has a pointed nose and aerodynamic brakes fitted on its after portion. Because of insufficient space in the wing, all three wheels of the tricycle undercarriage retract into the fuselage. Power plant and fuel tanks are contained in the fuselage, and an air-conditioned pressurised cabin in the nose. Power is provided by a Westinghouse 24C turbo-jet, and a rocket motor developed by Reaction Motors, Inc. Span is 25 ft. 0 in., length of fuselage, 44 ft. 6 in. and height, 11 ft. 6 in.

Beechcraft 34 "Twin-Quad" four-engined short-range commercial transport, described in "INTERAVIA, Review of World Aviation" Vol. II, No. 5, P. 49. (Cf. also Vol. II, No. 11, 1947, P. 57.)

● The *Bristol 171* helicopter, which made its first flight on July 24th, 1947, is likely to be subjected to an extensive flight test programme shortly. The prototype is powered by a Pratt & Whitney R-985 "Wasp Junior" air-cooled nine-cylinder radial of 450 H. P.,

Bristol 171.

though production units will be fitted with Alvis "Leonides" air-cooled nine-cylinder radials developing 525 H. P. Main rotor diameter is 47 ft. 5 in., tail rotor diameter, 9 ft. 7.3 in. ; height is 8 ft. 6 in. and length, 45 ft. 6 in.

● A model of the *SO 6020* fighter of the French nationalised *SNCA du Sud-Ouest* concern has been completed in order to demonstrate the internal construction. Serious preparations for production have already started at SNCASO's plant at Nantes.

● *Società Aeronautica Italiana (SAI)* is building a series of ten of its *SAI S.1001 "Grifo"* low-wing cabin monoplane. Apart from its originally intended use as a three-seater personal aeroplane, it is also being produced as a four-seater tourer, a light transport and as a trainer.

SAI S. 1001 "Grifo."

POWER PLANTS

● There is now a new version of the de Havilland "Goblin II" turbo-jet in existence, known as the *"Goblin III."* It only differs slightly from the "Goblin II," although by increasing the rotative speed from 10,200 to 10,750 r.p.m., a thrust increase of 300 lbs. has been achieved, bringing the static thrust up to 3,300 lbs.

● The Russians have developed an aero engine known as the *AM 42*, with which it is intended to power the IL-10 bomber (new version of the IL-3 "Stormovik" attack bomber). It is of in-line design, developing about 2,000 H. P. for take-off and may well be derived from the AM 38 or AM 38F liquid-cooled 12-cylinder in-line engines, of 1,600 H. P. and 1,700 H. P., respectively. The AM 42 and all engines of the AM series are designed by A. A. Mikulin.

● The *Nord 1200 "Norécrin"* three-seater personal or executive aeroplane, which has been in production at the SNCA du Nord plant for some time, has been certificated in the commercial transport class. A production "Norécrin" which has been in almost daily use over a period of 15 months recently completed 62,150 aircraft-miles. In the course of 500 hours in the air, it made 800 landings on airports in France, North Africa, Italy, the Middle East and Holland, and made four crossings of the Mediterranean without suffering the slightest mishap. All of SNCA du Nord's present backlog of orders for the "Norécrin" will be completed by next Spring, whenceforward the delivery period will be shortened.

● *Filippo Zappata,* the well-known Italian engineer, has returned from Argentina and is supervising production of the Breda-Zappata 308 commercial transport at the plant of Società Italiana Ernesto Breda. He brought an order for the BZ 308 from Argentina, where he also successfully arranged the granting of manufacturing rights. It will be recalled that Zappata originally supervised the construction of the prototype BZ 308.

INTERNATIONAL ORGANISATIONS

● ICAO : The International Civil Aviation Organisation will hold its *second assembly* in Geneva starting on June 1st, 1948. — On December 10th, *Pakistan* was accepted as the 45th Member State of ICAO. — ICAO is opening a South American branch office in Lima, Peru.

● IATA : The North Atlantic Communications Working Group of the International Air Transport Association has decided to put a plan for the *reorganisation of radio communications for North Atlantic air services* into operation on December 15th for an experimental period of six months. The scheme is based on the principle that if normal HF radio communications break down due to magnetic disturbances, trans-Atlantic aircraft will function as airborne VHF relay stations ; there are sufficient numbers of aircraft over the route at any time to operate a sufficient number of stations at all times. Should some of the aircraft be grounded by weather, the ICAO weather ships would be called upon to provide the VHF relays. According to Sir William Hildred, Director-General of IATA, airways, airports and ground aids lag many years behind the comparative development of aircraft ; the problem of filling in the gap was not with the airlines but with the Governments, since they had accepted airports as their responsibility.

AIR TRANSPORTATION

● Since November 22nd, *KLM Royal Dutch Airlines* has been operating four Douglas DC-4 flights weekly between Amsterdam and Batavia, via Rome, Lydda, Dharan, Karachi and Calcutta, Bangkok and Singapore, and three Lockheed "Constellation" flights weekly with intermediate landings at Rome, Basra and Karachi. DC-4 flights take four days and "Constellation" flights three. KLM hopes to replace the DC-4's with "Constellations" on all flights at a later date. On November 27th, KLM made its 100th round flight from Amsterdam to Curaçao via New York. At the end of November the eleventh Lockheed Model 749 "Constellation" for KLM arrived at Schiphol Airport, Amsterdam. Since November 17th, KLM has introduced a weekly landing at Hamburg on one of its three weekly round flights between Amsterdam and Gothenburg. — On November 18th, KLM modified the routing of its twice-weekly service to South America : one of the flights from Amsterdam called at

* Excerpts from Nos. 1385-1396 (Nov. 11th to Dec. 6th, 1947) of "Interavia, International Correspondence on Aviation," an illustrated newsletter published thrice weekly in four language editions, English, French, Spanish and German.

Rome and Casablanca instead of Lisbon ; the remaining intermediate landings at Dakar, Natal, Rio de Janeiro and Montevideo remain the same. Thus Italy now has a weekly direct service by KLM to South America.

● In the middle of November, the Anglo-Italian *Alitalia*, the Italo-American *Linee Aeree Italiane (LAI)* and the Fiat Group's *Avioliee Italiane (ALI)* signed an agreement concerning the distribution of Italian routes and bound themselves to support one another to have this programme passed by the Government. An agreement on aircraft procurement has also been prepared.

● The basis for a civil aviation authority and an airline company have been formed in Austria. The company is once more known as *Oesterreichische Luftverkehrs-AG. (OLAG)*. (The OLAG was taken over by the German Lufthansa on December 31st, 1938.) The civil aviation authority takes the form of a Civil Air Office in the Ministry of Transport.

● *British European Airways Corp.* is planning to open regular domestic services in Germany, between Berlin, Hamburg and Frankfurt, in January 1948. Discussions with the British Control Commission were initiated at the beginning of November to this end. Fares will be payable in marks.

● In the spring of 1948 British European Airways Corp. will operate an experimental helicopter mail service in East Anglia, with the aircraft based at Peterborough. To prepare for this service a dummy-mail route has been started in the West Country, with the factory airfield of Westland Aircraft Co. at Yeovil, Somerset, serving as base. Westland, it will be recalled, is building Sikorsky S-51 helicopters under licence.

● On December 3rd, *Swedish Air Lines (ABA)* intensified its Stockholm-Gothenburg-London service schedule to seven round flights weekly. Thus the service is again a daily one, having originally been reduced to three flights weekly due to an anticipated decline in traffic caused by the ban on British tourist travel abroad.

● On November 28th, the privately-owned *Svensk Interkontinental Lufttrafik A.B. (SILA)* agreed to its *merger* with the Government-owned *ABA*, as proposed by a Swedish parliamentary civil aviation committee. The merger is scheduled to take place on July 1st, 1948. The new ABA will have a share capital of between 60 and 180 million Swedish kroners, made up of equal State and private contributions. Since the new ABA will take over SILA's part in Scandinavian Airlines System, SAS will not be affected by the merger.

● Since November 28th, the ground staff and stewardesses of the Swedish ABA (some 1,200 employees) have been on strike and ground services at Stockholm and other airports have been at a standstill. SAS has modified its schedules so that services terminate at Copenhagen, passengers continuing to Stockholm by rail. The strike may last for three months.

● The Norwegian *DNL* plans to extend its North Cape service to Spitzbergen via Harstad.

● British Overseas Airways Corp.'s Iraqi subsidiary, *Iraqi Airways*, is planning to open a Baghdad-Nicosia-Athens-Rome-Marseilles-London service. It is re-equipping its fleet with three Vickers "Vikings" and three de Havilland "Doves" ; the London service will enable the former aircraft to be overhauled in England.

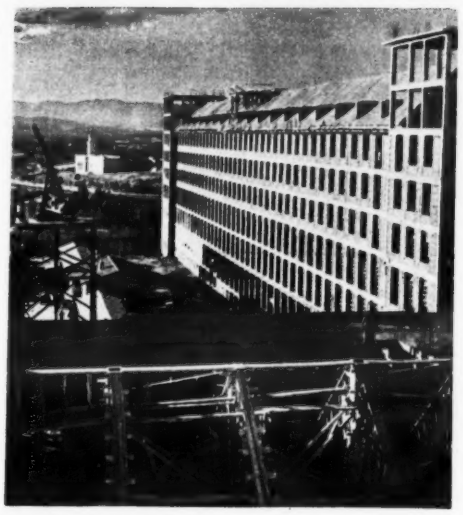
● *Air India-International* is the name of a new company formed by the Indian Government and Air India Ltd. to operate a twice-weekly service from India to London via Cairo. The route is expected to be opened in May, 1948.

● On December 1st, *Qantas Empire Airways* opened the first through Australian service from Sydney to London with its four new Lockheed "Constellations." The route will initially be flown once weekly and will later be intensified to three flights each fortnight.

● Although the U.S. Civil Aeronautics Board has proposed that all Douglas DC-3's be retired from airline service by December 31st, 1950, the price for surplus aircraft of this type recently rose from $20,000 to $35,000.

● United Air Lines has asked the Civil Aeronautics Board for its mail pay to be increased from the present 45 cents per ton-mile to $1.25 per ton-mile for 1948. It bases this claim on increases in operating costs and the decline of mail loads from war-time levels.

● Argentina and Equador recently abolished special taxes imposed on airline traffic : Argentina's tax levied ten per cent. on all tickets and two per cent. on all freight consignments. Equador imposed a five per cent. tax on all airline profits and a charge of two dollars per head on all through passengers.



New Air Ministry building in Madrid.

● AIRPORTS : American Overseas Airlines is building a hotel with 400 beds on Rhine-Main Airport, Frankfurt (which it manages for the U. S. occupational authorities), and a city terminal in Frankfurt itself, with sleeping accommodation for 200 passengers.

SERVICE AVIATION

● On November 19th, the French Council of Ministers approved a Bill for a re-organisation of the Armed Forces, providing for a joint general staff.

● During 1947, damage totalling £20,000 was caused to R.A.F. aircraft by birds, mostly in the vicinity of airfields. In order to discourage the congregation of flocks of birds on airfields, experiments are being conducted at the R.A.F. base at Shawbury, Shropshire, with the introduction of peregrene falcons.

● Plans for the merger of the USAF's Air Transport Command and the Naval Air Transport Service have been rejected by the two Services. However, the discussions are all the same expected to result in closer co-ordination of ATC and NATS activities.

● The USAF has recently activated 250 Boeing B-29 "Super Fortress" bombers, 400 North American P-51 "Mustang" and Republic P-47 "Thunderbolt" fighters. These 650 aeroplanes are being used to bring the Air Force's strength up to 55 fully-equipped groups.

PRIVATE FLYING

● An official Belgian announcement states that the reduction of landing fees for light aircraft and trainers (75 per cent. reduction for flights returning to the airport of departure and 50 per cent. for landing at another field) only applies to solo flights.

The new Board of Directors of Consolidated Vultee Aircraft Corp. Following the company's re-organisation, Atlas Corp. is now the largest single shareholder, possessing some 25 per cent. of the Convair share capital. Left to right : V.C. Shorlemmer (Vice-President, Finance), Joseph H. Rosenberg, Louis A. Johnson, Donald N. McDonnell, Richard C. Patterson, Jr., George H. Shaw, C. E. Groesbeck, Floyd B. Odlum (Chairman of the Board), Sydney R. Inch, Oswald L. Johnston, Harry Woodhead (President of Convair), I. M. Laddon (Vice-President and Managing-Director), Ben O. Howard, William C. Rockefeller and Emmett A. McCabe. The other two members of the Board of Directors, William A. Blees (Vice-President, Sales) and John Hertz, are not in the photo.

PHOTO CREDITS :

Cover page : Manufacturers ; P. 12-18 : Interavia Archives ; P. 20-26 : A. U. Schmidt (5), Manufacturers (10) ; P. 27-34 : Authors ; P. 34-35 : Manufacturers (3), Interavia Archives (1) ; P. 36-38 : Author ; P. 38-42 : Authors ; P. 43-46 : Canadian Pacific Air Lines ; P. 47 : Manufacturers ; P. 48-49 : Author (3), International News Photos (1), Charles E. Brown (1) ; P. 53-54 : Interavia Archives ; P. 57-58 : Manufacturers (3), U. S. Navy (1), Interavia Archives (2).

PARTOUT LA PRÉSENCE FRANÇAISE DANS LE MONDE SE MANIFESTE D'UNE FAÇON PERMANENTE, GRACE A AIR FRANCE QUI DESSERT 120 CENTRES RÉPARTIS DANS 35 PAYS ÉTRANGERS ET 20 TERRITOIRES DE L'UNION FRANÇAISE

AIR FRANCE

SIÈGE SOCIAL : 2, RUE MARBEUF, PARIS — TÉLÉPHONE ÉLY. 20-60
AGENCE CENTRALE : AIR FRANCE 119, CHAMPS-ÉLYSÉES, PARIS — TÉL. BAL. 50-29

ESSO IS GOING EVERYWHERE NOW!

ESSO, in its more than forty years of aviation experience, has met all service problems and is capably equipped to handle new problems as they arise.

Famed as well for industrial, transport and automotive services, ESSO displays its familiar oval along the airways of the world, providing private owners, great airlines — in fact, all airmen — with petroleum products of the highest quality.

For quality, fine performance, reliability — pilots as well as motorists look to ESSO... all around the world.

ESSO AVIATION PRODUCTS